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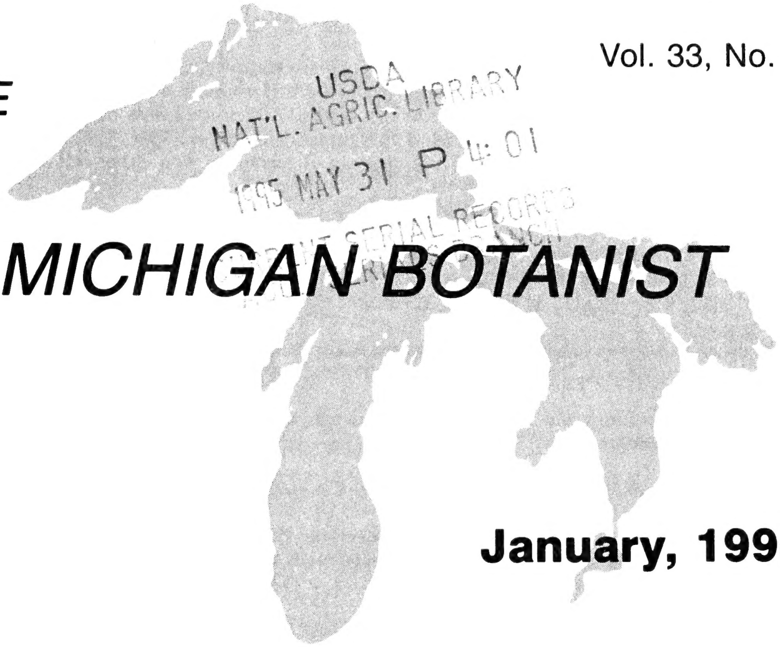
THE MICHIGAN BOTANIST



January, 1994

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THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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THE BIRD'S-FOOT VIOLET (*VIOLA PEDATA* L.) IN CANADA: POPULATION BIOLOGY AND ECOLOGY OF A THREATENED SPECIES[1]

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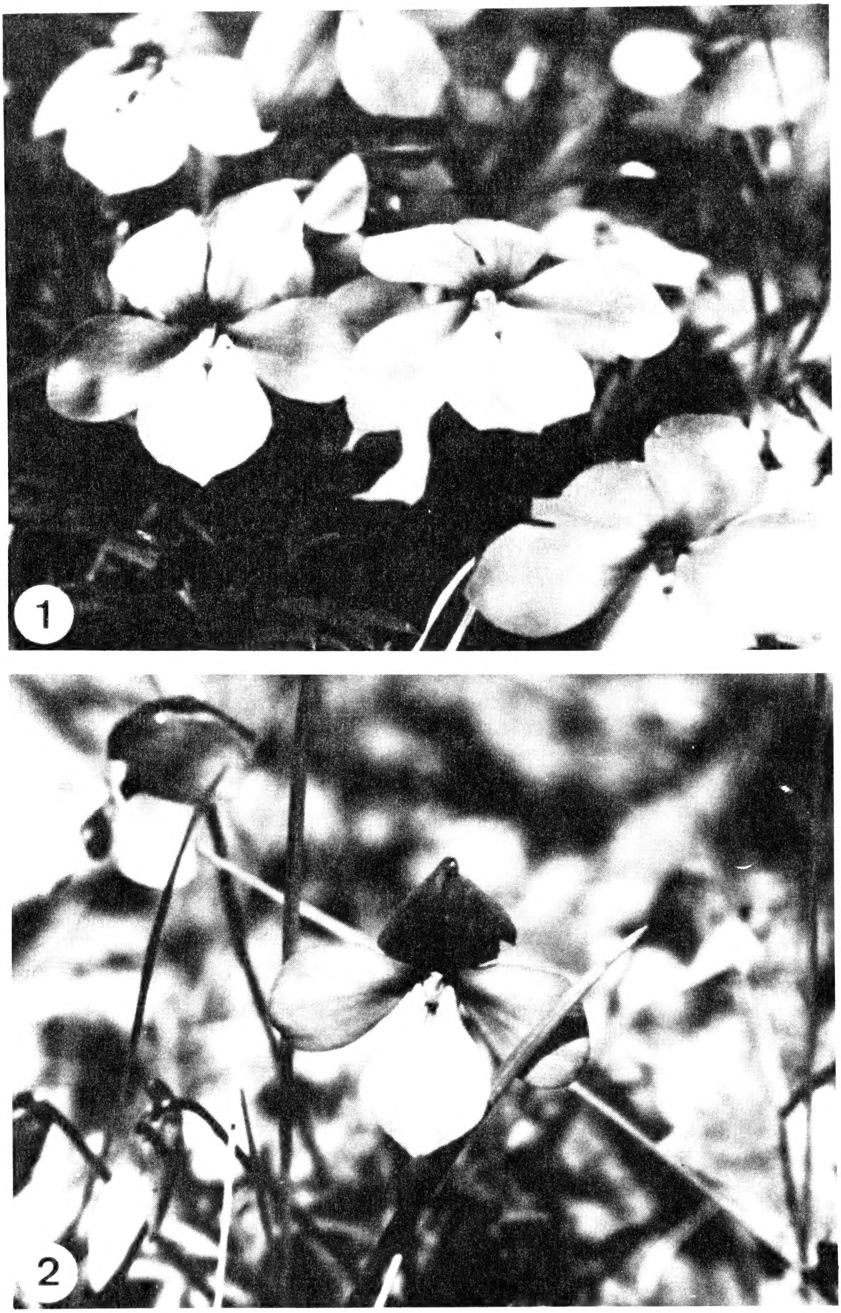
The bird's-foot violet (*Viola pedata* L.) [$n = 27$ (Canne 1987)] is one of the most polymorphic members in North America (Brainerd 1921) of this attractive genus, known to contain over 400 species world-wide (Jones and Luchsinger 1986). It is a stemless, herbaceous, spring- and autumn-flowering perennial with peduncles (5–15 cm long) and petioles (2.5–12.5 cm long) arising directly from erect, non-stoloniferous rhizomes. The leaves are principally three-parted with the lateral segments further divided into three to five divisions which are linear to lanceolate in outline. Leaf morphology varies considerably along a north-south gradient with northern populations possessing more highly dissected leaves, possibly as a response to the longer daylengths of summer (Russell 1965). The flowers are single, with the corolla 1.5–4.0 cm wide. The variety *lineariloba* DC. (Figure 1) has flowers all lilac purple in color and is more northern, while var. *bicolor* Pursh ex Raf. (Figure 2), more commonly found in the southern portion of the range, has the upper two petals dark violet and the lower three petals lilac-colored. In addition, there exists var. *concolor* Holm which has large flowers, lighter in color than var. *lineariloba* and with a conspicuous white base on the lower petal. It is restricted to the southern end of the range. Plants with white flowers, irrespective of the variety, are usually assigned to the forma *alba* (Thurb.) House. The flower colors are genetically inherited (Russell & Bowen 1960) and are not linked with the varying leaf forms (Baird 1942).

Because of the limited occurrence of *Viola pedata* in Canada, the purpose of this paper was to examine remaining extant populations of this species and determine its distribution, status, and ecology.

[1]Based on a COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status report by the authors. Copies of the complete report are available at cost from the Canadian Nature Federation, 1 Nicholas Street, Suite 520, Ottawa, Ontario K1N 7B7. Threatened status was approved and assigned by COSEWIC in April 1990.



FIGURES 1–2. *Viola pedata* from Turkey Point Provincial Park, Ontario. 1. *V. pedata* var. *lineariloba*. 2. *V. pedata* var. *bicolor*.

DISTRIBUTION

Viola pedata has a wide distribution in North America (Figure 3) encompassing most of the eastern United States north of Florida and west to Minnesota, Iowa, Kansas, Oklahoma and eastern Texas. Disjunct populations occur in northern New York and southern Ontario, centered around Lakes Erie and Ontario. In Canada, *V. pedata* is confined to the Niagara River region and near Lake Erie (Figure 4).

Viola pedata cannot be transplanted with success (Pepoon 1927, Smith 1961); therefore wild populations are not believed to be a result of successful garden escapes.

Viola pedata has been known in Ontario since 1885, when it was first collected from Norfolk Co. by A. Gates, who found it growing near Normandale (TRT 22016). It is in this region, in and around Turkey Point Provincial Park, where most of the known herbarium specimens of *V. pedata* from Canada have been collected. Other early collections from Ontario were made by J. Dearness, who collected it from London (Middlesex Co.) in 1890 (UWO 900831) and from Niagara-on-the-Lake (Niagara Co.) in 1891 (DAO 391835), and by R.T. Anderson from Paris (Brant Co.) sometime in the 1880's (TRT 22015). A collection was made by C.K. Dodge from "near Lake Huron" in Lambton Co. (MICH 80601) in 1908. This vague location reference could possibly be near present-day Pinery Provincial Park. Recent surveys in the 1980's have found extant *V. pedata* populations to occur only at and near Turkey Point Provincial Park and Brantford (Table 1).

Previously, only *V. pedata* var. *lineariloba* had been reported from Canada (Ballard 1987). However, our field work has discovered that individuals of *V. pedata* var. *bicolor* were found growing in Ontario along with var. *lineariloba* (Figs. 1 and 2). Plants with nearly all white flowers were noted as well and can be considered as forma *alba*. All the varieties occurred at Turkey Point, but only var. *lineariloba* was found at Brantford.

HABITAT

In Canada *Viola pedata* is restricted to the Carolinian or Deciduous Forest Region (Maycock 1963, Rowe 1972). All populations are confined to open mixed black oak (*Quercus velutina* Lam.) and white oak (*Quercus alba* L.) savannas where periodic groundfires likely maintained relatively open forest cover. Because of the lack of recent fires these savannas have reverted largely to closed canopy forests, and extant *V. pedata* populations are confined mainly to areas kept open by human disturbance. For example, at Turkey Point Provincial Park most plants are located along a hydro right-of-way and in an adjacent campsite and picnic grounds. The Brantford site appears to have been maintained in a savanna state by cattle grazing (G. Allen, unpublished data) and the area immediately surrounding the *V. pedata* population by occasional mowing. In the nearby American states of

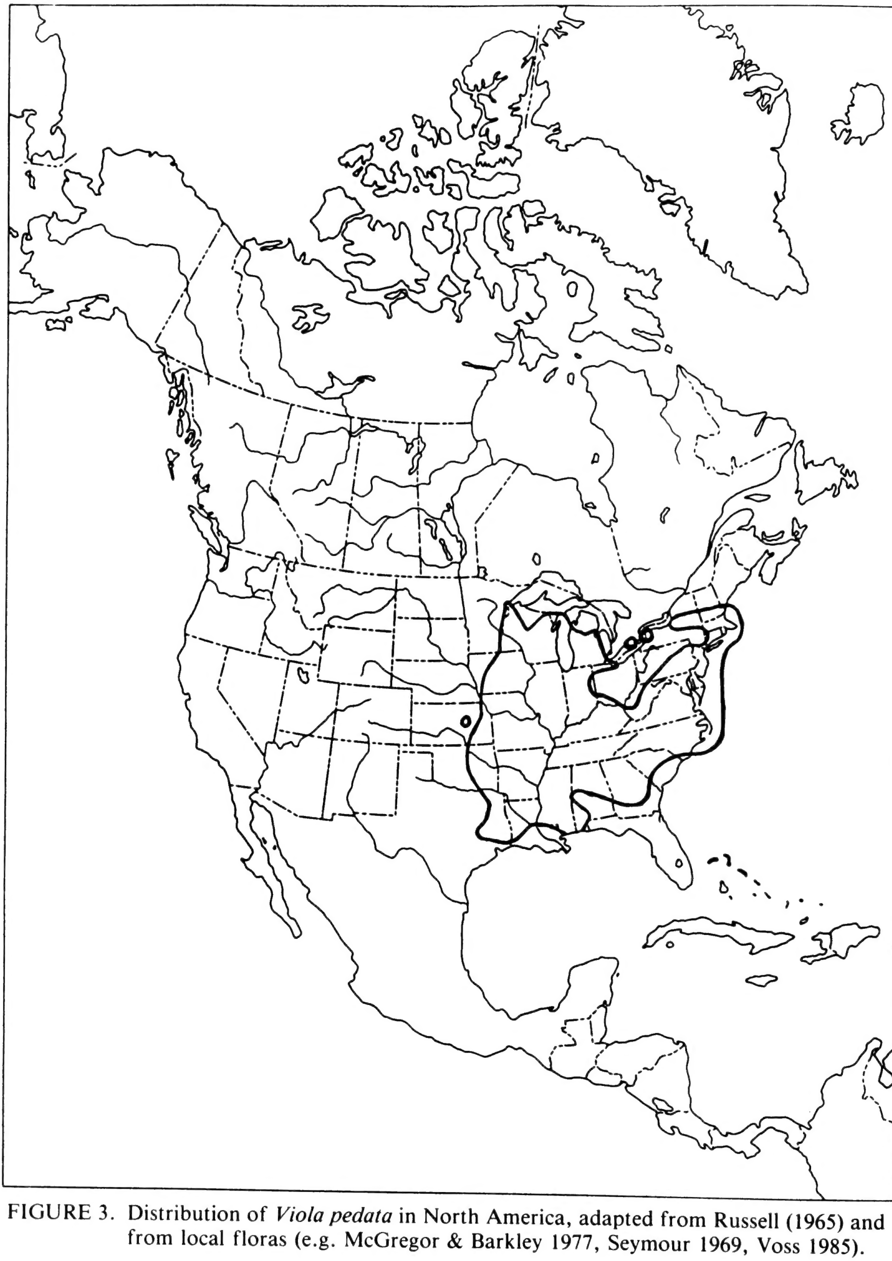


FIGURE 3. Distribution of *Viola pedata* in North America, adapted from Russell (1965) and from local floras (e.g. McGregor & Barkley 1977, Seymour 1969, Voss 1985).

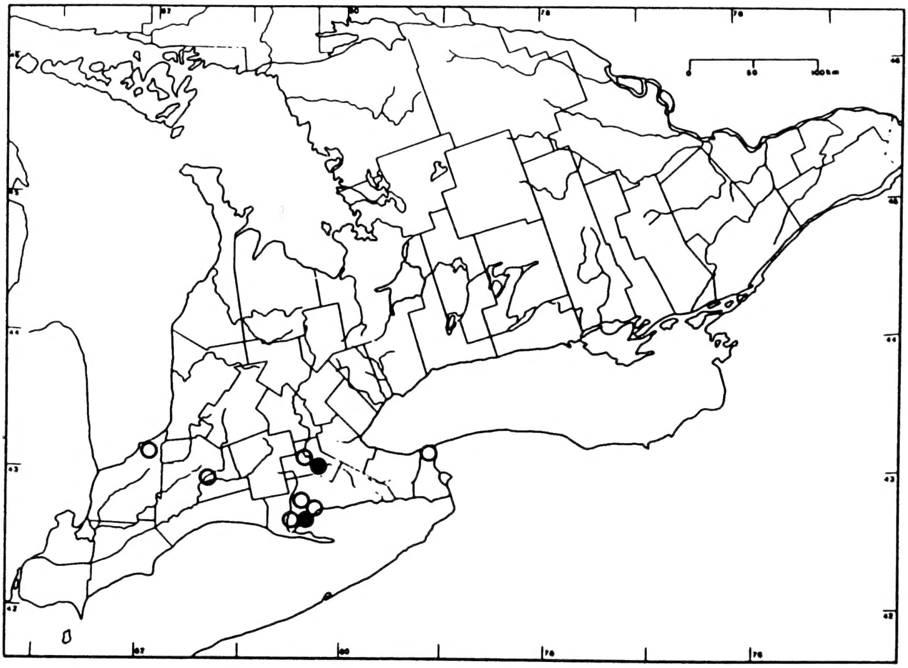


FIGURE 4. Distribution of *Viola pedata* in Ontario. Solid circles (●) represent collections from extant populations, open circles (○) represent collections from historical populations.

Michigan (Voss 1985), Illinois and Indiana (Swink & Wilhelm 1979), *V. pedata* is found in a variety of open habitats, including open sand plains with *Pinus banksiana* Lamb. and/or oaks, shoreline high dunes with scattered *Quercus velutina* and *Sassafras albidum* (Nutt.) Nees, sandy *Quercus velutina* woods, especially those with a history of fire, and black-soil prairies.

The vegetation associated with *Viola pedata* at the Turkey Point and Brantford sites is summarized as follows. The tree layer at or adjacent to the *V. pedata* sites is dominated by black oak (*Quercus velutina*) in Turkey Point and with a co-dominance of black oak and white oak (*Quercus alba*) in Brantford. Most prevalent in the scattered shrub layer are *Prunus virginiana* L., *Vitis riparia* Michx., *Rhus typhina* L., *Rubus strigosus* Michx., *Cornus racemosa* Lam., and *Parthenocissus vitacea* (Knerr) Hitchc. The understory is dominated by such graminoid species as *Andropogon scoparius* Michx., *Poa pratensis* L., *Carex foenea* Willd., *Poa compressa* L. and *Carex pensylvanica* Lam. Common herbaceous associates include *Hieracium* spp., *Rumex acetosella* L., *Antennaria neglecta* Greene, *Aster ericoides* L., *Solidago canadensis* L., *Helianthemum canadense* (L.) Michx., *Helianthemum bicknellii* Fern., *Fragaria virginiana* Duchesne, *Daucus carota* L., *Solidago nemoralis* Ait., and *Pteridium aquilinum* (L.) Kuhn.

TABLE 1: Locations and representative collections of *Viola pedata* in Canada.

Location	Collector	Collection date	Herbarium & Collection No.
Brant Co., Ontario			
1. Brantford Twp., between Brantford and the Brantford airport. (verified 1987).	B.A. Ford & W. Bakowsky	28 May 1986	TRTE 41536
2. South Dumfries Twp. Mun., Paris. (an extensive search in 1989 failed to relocate *V. pedata*).	R.T. Anderson	1880–1900	TRT 22015
Haldimand-Norfolk Co., Ontario			
3. Delhi Twp. Mun., Turkey Point Provincial Park. (verified 1989).	S.L. Thompson	21 May 1933	TRT 137399
4. Delhi Twp. Mun., St. Williams Forestry station (Turkey Point), immediately west of park. (verified 1987).			
5. Delhi Twp. Mun., 2.4 km north of Turkey Point Provincial Park.	J. Maze	6 May 1967	TRT 155851
6. Delhi Twp. Mun., Normandale.	R.F. Cain	12 June 1928	TRT 132546
7. Delhi Twp. Mun., 1.6 km north of Normandale (an extensive search in 1987 failed to relocate *V. pedata*).	J.E. Cruise	11 June 1960	TRT 600611
8. Delhi Twp. Mun., Vittoria.	G.M. Stirrett	23 May 1936	DAO 391839
9. Delhi Twp. Mun., Forestville.	T.M.C. Taylor	21 May 1937	TRT 84170
10. Norfolk Twp. Mun., St. Williams. (suitable areas searched in 1987 failed to locate any plants).	F.Marie-Victorin	3 July 1936	DAO 391840
11. Norfolk Twp. Mun., Backus Woods (an exhaustive search during 1986 & 1987 failed to relocate *V. pedata*).	J.H. Sparling	5 May 1963	TRT 135223
12. Simcoe Town Mun., Simcoe.	J. Dearness	6 June 1905	DAO 391842
Lambton Co., Ontario			
13. near Lake Huron. (an exhaustive search in 1988 failed to relocate *V. pedata* in the vicinity of Pinery Provincial Park).	C.K. Dodge	1 June 1908	MICH 80601
Middlesex Co., Ontario			
14. London Twp., London (a survey of environmentally significant areas in Middlesex Co. failed to relocate *V. pedata*).	J. Dearness	13 August 1890	UWO 900831
Niagara Regional Municipality			
15. Niagara-on-the-Lake, 4 Mile Creek. (an exhaustive search during 1988 failed to relocate *V. pedata*).	J. Dearness	4 August 1891	DAO 391835

The soils associated with *V. pedata* (Table 2) are of a sandy loam/silty sand type which are well drained and tend to be very dry throughout much of the late spring and summer. These soils have a slightly acidic pH (5.1 to 6.6) and possess a C/N ratio of 11.6 to 16.0.

DEMOGRAPHY

There are three known extant sites of *Viola pedata* in Ontario. In May 1987, the Brantford and Turkey Point sites were visited to determine demography. The Turkey Point Provincial Park site supported a total of about 10,000 plants. A high density population of approx. 7,000 plants covered approximately 300 square meters of a hydro right-of-way in the park (Figure 5). A further 300 plants occurred in small clumps along the hydro corridor to the west of this major population. Other populations scattered throughout the park (e.g. picnic and campgrounds) accounted for a few thousand additional plants. The St. Williams Forestry Station (Turkey Point) site supported about 100 widely scattered plants (D. A. Kirk, pers. comm.). The Brantford site sustained a total of ca. 3,300 plants at 6 locations. The largest population covered an area of approximately 100 square meters. All of the numbers listed above were for *Viola pedata* var. *lineariloba*. The main population at Turkey Point Provincial Park (along the hydro right-of-way) also supported 10 plants of *Viola pedata* var. *bicolor* and 2 plants which could be considered as the white form (forma *alba*).

Non-flowering plants (including seedlings) comprised approximately

TABLE 2: Edaphic parameters associated with *Viola pedata* in Ontario

VARIABLES	SITE		
	BRANTFORD	TURKEY POINT High density	TURKEY POINT Low density
Soil type (0←15 cm)	sandy loam/ silty sand	loamy sand/ sand	sandy loam/ silty sand
% sand	69	87	72
% silt	24	7	21
% clay	7	6	7
Organic Layer			
L (depth in cm)	trace	trace	0–2.0
F (depth in cm)	–	–	trace–1.0
H (depth in cm)	–	–	–
pH (0–15 cm)	6.6	5.1	5.5
% carbon	1.51	1.16	3.36
% nitrogen	0.11	0.10	0.21
C/N ratio	13.6	11.6	16.0

FIGURE 5. High density population of *Viola pedata* along hydro right-of-way, Turkey Point Provincial Park, Ontario.

70% of the individuals at the Brantford site whereas among the populations at Turkey Point Provincial Park, only about 40% of the individuals were non-flowering (Figures 6 & 7). It was also noted that flowering intensity (number of flowers per plant) was much lower in the Brantford population compared with plants at Turkey Point. These two factors may suggest that conditions are less ideal for the Brantford population compared with those at Turkey Point.

Shading by forest canopies has a negative effect on *V. pedata* populations, as is illustrated along two perpendicular transects through the largest populations at each of the Turkey Point and Brantford sites respectively (Figures 6 and 7). It appears that at the south end of the transect through the main population at Turkey Point (Figure 6) even low-density oak canopies are sufficient to effectively eliminate *V. pedata*. The sudden drop in numbers of *V. pedata* on the north end of the transect may indicate other environmental factors limiting its numbers at that location. A similar tree canopy effect is noted at the NNW end of the transect at the main Brantford population (Figure 7) where the open savanna changes into forest. Also noted for the high density population at Brantford was the observation that shading by a small black oak sapling was sufficient to reduce the number of *V. pedata* beneath it, particularly the number of individuals

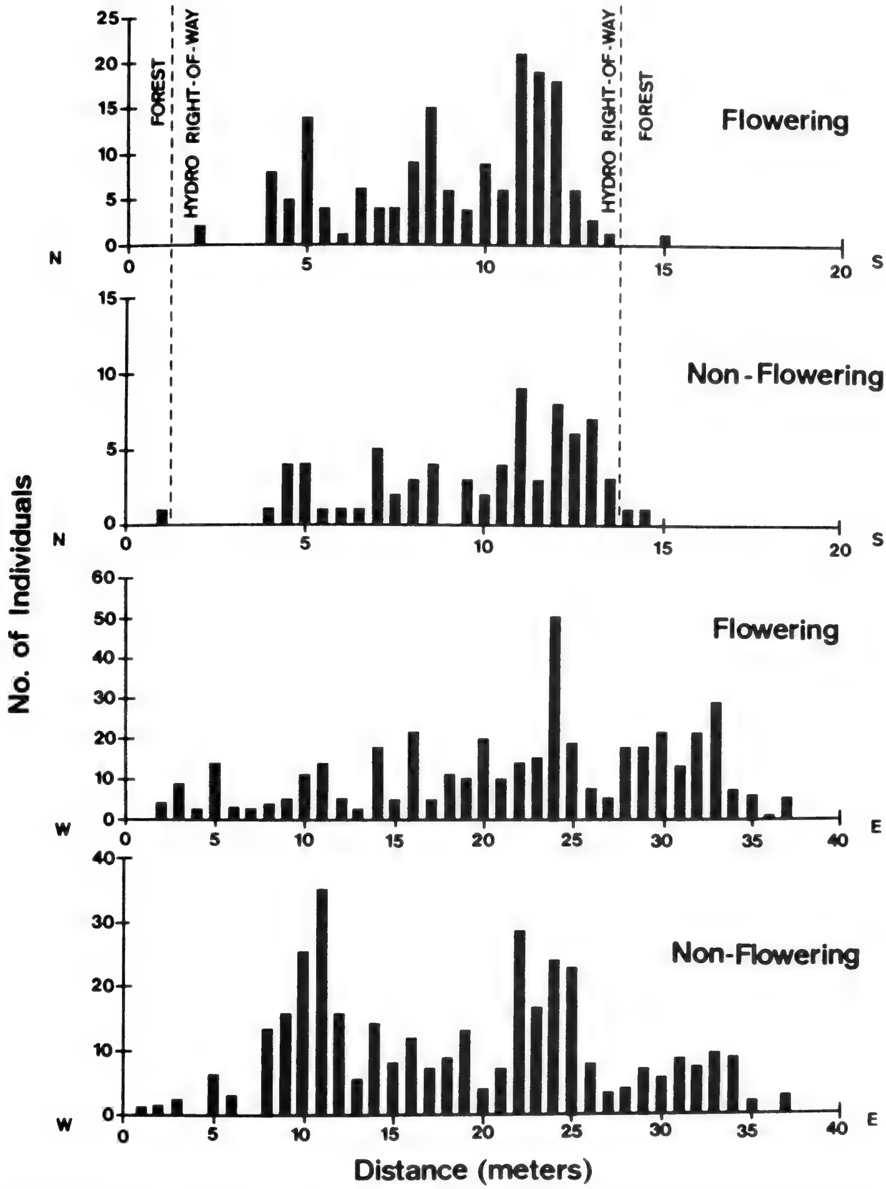


FIGURE 6. Population distribution of *Viola pedata* along two transects, at high density site along hydro right-of-way, Turkey Point Provincial Park, Ontario. Note vertical scales. See text for explanation.

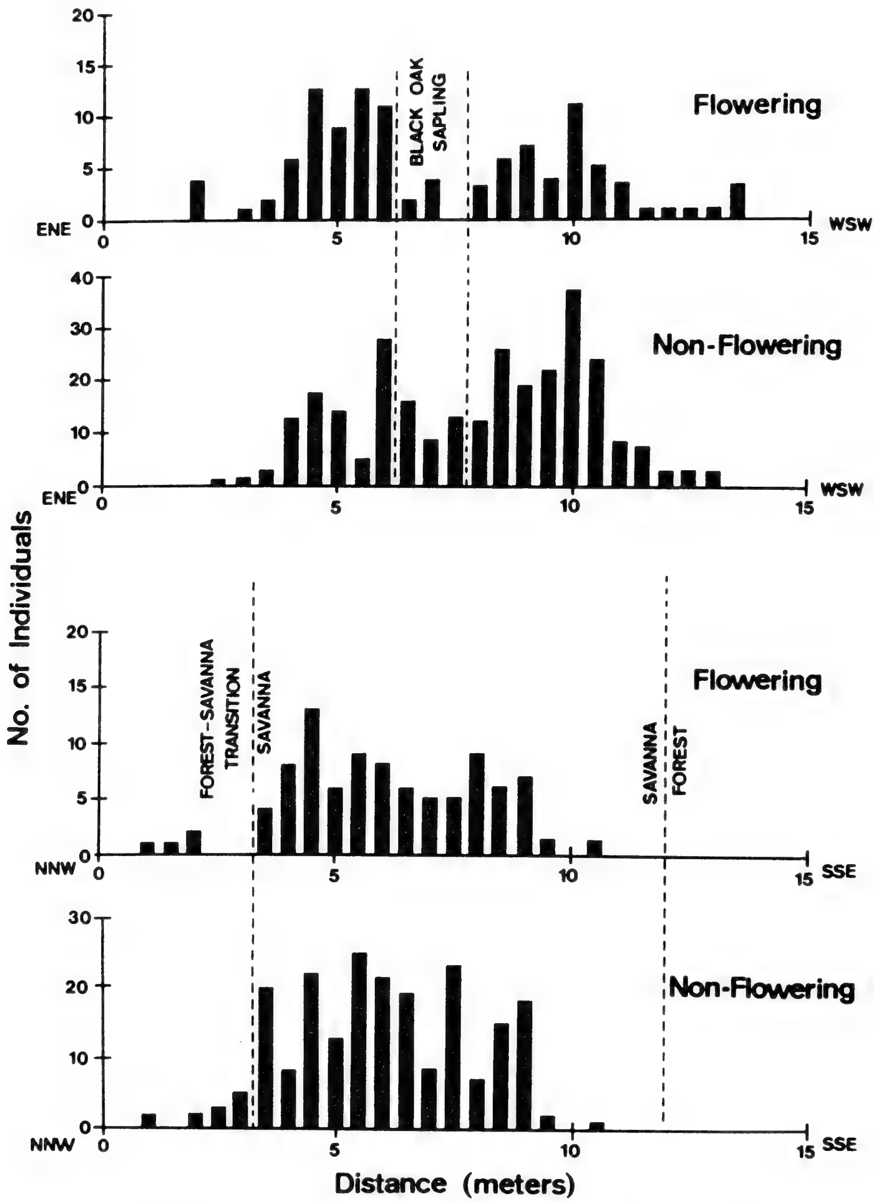


FIGURE 7. Population distribution of *Viola pedata* along two transects, at high density site, Brantford savanna, Ontario. Note vertical scales. See text for explanation.

which were flowering (Figure 7). These distributional patterns highlight the need of *V. pedata* for open savanna in order to flower successfully.

A wide range in rosette size was noted among flowering and nonflowering plants along all transects at both sites, possibly indicating that individual plants could be long-lived. Many small non-flowering seedlings that had been established at least in the previous year suggested that rosettes often require two or more years before flowering is initiated, and that recruitment may be taking place in the population even though expansion of the population may not be occurring. Poor seed germination (Cohen 1988), a short dispersal range, and relatively slow maturation indicate that colonization of new areas may be a slow process. Although showing a preference for slightly disturbed habitats, this species does not appear to possess a life-history characteristic of an r-selected weedy species sensu Harper (1977).

REPRODUCTIVE BIOLOGY

Depending on climatic conditions in Ontario during any particular year, *Viola pedata* flowers from early May until mid-June (May 5 to June 12) and will flower again from the end of September until mid-October. The autumn flowering is not as profuse, and observations indicate that few flowers set seed in the autumn. As many as 80 flowers were recorded on the largest plants (Turkey Point) although most individuals possessed 30 or fewer. Five to ten flowers were most commonly observed on plants in the Brantford population. *Viola pedata*, unlike most violets, has only chasmogamous flowers and possesses a breeding system that is self-incompatible (Seymour 1969). Although many violet species hybridize readily, *V. pedata* has only been reported once as possibly hybridizing with *V. primulifolia* L. subsp. *villosa* A. Eaton (Russell & Bowen 1960). However, this report remains unconfirmed. In addition, as *V. pedata* is non-stoloniferous, it does not reproduce vegetatively (Cohen 1988).

Although not observed during our study, *Viola pedata* is reported to be pollinated by both long- and short-tongued insects, with solitary bees, bumblebees, and Lepidoptera (butterflies and moths) accounting for 95% of all visiting pollinators (Beattie 1974). Once the seeds have matured, they are dispersed by diplochory, i.e. forcible discharge followed by ant dispersal (Beattie & Lyons 1975, Culver & Beattie 1978). The seeds are initially ejected by ballistic mechanisms for distances ranging from 25 cm up to 510 cm (average = 140 cm) (Beattie & Lyons 1975). Once on the ground, the seeds are then picked up by harvesting ants [e.g. species of *Aphaenogaster*, *Myrmica*, *Leptothorax*, *Tapinoma*, *Formica*, and *Lasius* (Culver & Beattie 1978, Hölldobler & Wilson 1990)] and transported another 35 cm on average (max. 150 cm) to the nests (Culver & Beattie 1978). It has been suggested that the advantages of ant dispersal and relocation to ant nests result in reducing predation on the seeds by butterfly larvae, small mammals, and birds, as well as increasing the germination stimuli (Culver & Beattie 1978). Alternatively, seed dispersal by ants and relocation to their nests, which are common for plants in fire climax communities, allow for the protection of the seeds during frequent burnovers of *V. pedata* habitat, and/or the high temperatures generated by fires may stimulate seeds to germinate in the nests (Hölldobler & Wilson 1990). Whichever the case, seed germination is relatively poor otherwise (Cohen 1988).

Seedlings of *V. pedata* become established only on sites appropriate for the species [i.e. open, disturbed, well drained, sandy sites, with a slightly acidic soil of low nutrient status (Cohen 1988)]. In Ontario, this is supported by observations of seedlings which were found in close proximity to mature plants with little dispersal beyond the colonies (Figs. 6 & 7).

LIMITING FACTORS

Destruction of critical habitat due to pressure from agriculture was primarily responsible for eliminating most known sites of *Viola pedata* in Ontario. Only 10 locations of significant black oak savanna remain in Ontario (Bakowsky, unpub. data). Historically, low-intensity fires periodically swept through black oak savannas, restricting woody shrub growth and the establishment of tree species (Nuzzo 1986, Bakowsky 1988). Without such fires, both woody and herbaceous vegetation shade and/or overgrow *V. pedata* relatively quickly and thus are the major threat to this species' long term survival in Canada. Annual prescribed burning on a *Quercus ellipsoidalis* E.J. Hill savanna in Minnesota over a thirteen-year period resulted in a significant increase in the percentage frequency of *V. pedata* in burned areas versus unburned areas (White 1983). Because of the suppression of such fires by man, remaining populations in Ontario occur in open, lightly disturbed sites.

Human activities may pose a problem with regard to degrading a certain percentage of the remaining populations within Turkey Point Provincial Park. Close-cropped mowing in the picnic ground was observed to have severed the new growth of some plants, with an impact on flowering and subsequent seeding. In addition, tire tracks observed along the hydro right-of-way seem to be degrading the main population. Where tire tracks had compressed the soil, dead plants were noted. Human activity, however, poses the greatest threat to the *V. pedata* population at Brantford. The population exists on private land, and a newly dug garden plot and a new access drive had degraded and reduced the population in 1987. Mowing and footpaths were also having a destructive impact. Recently, the Brantford oak savanna was reported to have been destroyed by the building of a residential estate on the site (Brown 1993).

Horticultural collection has been noted at the Turkey Point site, where plants have been removed along the hydro right-of-way by visitors to the park. Owing to the specific growing requirements of, and difficulties in transplanting, *V. pedata* (Pepoon 1927, Smith 1961, Cohen 1988), this removal essentially seals the fate of those individual plants. In particular, excavation adjacent to plants of var. *bicolor* indicates that these individuals may be most heavily impacted. Only found at Turkey Point, this variety is rare in comparison to the var. *lineariloba*. Fewer than 10 plants of var. *bicolor* could be located in 1987.

SUMMARY

Viola pedata is a herbaceous, spring- and autumn-flowering perennial that is widely distributed in the eastern United States but restricted in Canada to three localities within the Carolinian life zone. The extant Ontario populations are near Brantford and at Turkey Point. They occur in open mixed white and black oak savannas on sandy, nutrient-poor sites that have been slightly disturbed. *Viola pedata* is highly sensitive to shade, with flowering significantly reduced even in partial shade. The southern form of this species, var. *bicolor*, is reported from Canada for the first time, joining the more frequently encountered northern form, var. *lineariloba*. While the populations at both sites in Ontario are relatively large, the plant's declining numbers (e.g. loss of 75% of its historical distribution) and dependence on a very restricted and rare habitat type (e.g. fire-dependent savannas) has resulted in its official designation by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as a threatened species in Canada.

ACKNOWLEDGMENTS

We are grateful for the field assistance given by members of the University of Toronto Botany Conservation Group (S. Varga, E. Schwärtzel, C. Adkins, S. McKay-Kuja, T. Gray and G. Thorn), and information provided by W. Bakowsky, G. Allen, D.A. Kirk, J. Gould and D.A. Sutherland. We would also like to thank Harvey E. Ballard Jr. who searched all relevant herbaria for specimens of *V. pedata* for the *Atlas of the Rare Vascular Plants of Ontario*. Financial assistance was provided in part by the University of Toronto Botany Conservation Group.

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EDITORIAL NOTICE: BUSINESS MANAGER NEEDED

The Michigan Botanist is in need of a Business and Circulation Manager. Judy Kelly has held this position for the last year and a half and has completed the nightmarish task of compiling our entire subscription list onto a master database to comply with new postal regulations. Unfortunately for us, Judy has taken on new responsibilities in the Biology Department at Henry Ford Community College (congratulations, Judy!) and can no longer continue as Business Manager of the *Botanist*. Many thanks to Judy for all her work.

The Business and Circulation Manager handles all the financial matters for the journal, including subscription inquiries from institutions, requests for back issues, and payments from the chapters of the Michigan Botanical Club for their members' subscriptions. It would be possible for the job to be shared among 2 or 3 people. If you are willing to take on any part of this essential role, please contact me as soon as possible.

——Barbara J. Madsen

OBITUARY

William S. Benninghoff (1918–1993)

Dr. William S. Benninghoff, Professor Emeritus of Botany at the University of Michigan, died on 3 January 1993 in Ann Arbor. Interment was at Arlington National Cemetery.

Professor Benninghoff was born 23 March 1918 in Fort Wayne, Indiana. He received his degrees from Harvard: an S.G. (magna cum laude) in 1940, an A.M. in 1942, and a Ph.D. in 1948. During World War II he enlisted in the Navy, where he served aboard the U.S.S. Tatum in the Mediterranean, Atlantic, and Pacific. He retired from the Navy in 1960 as a Lieutenant Commander (Intelligence).

In 1948 he joined the U.S. Geological Survey and spent the next several years studying the relationships between vegetation and permafrost in Alaska. From 1953 to 1957 he served as Chief of the Alaska Terrain and Permafrost Section. In 1957 he came to the Department of Botany at the University of Michigan as an associate professor, was promoted to full professor in 1960, and retired in 1988. From 1977 to 1986 he was also Director of the Matthaei Botanical Gardens.

Dr. Benninghoff's contributions to botany were many and varied. In 1947, as a graduate student, he developed the trisodium phosphate technique for the examination of organic sediments. During his tenure with the U.S.G.S., he demonstrated the control by different kinds of vegetation on heat transfer to permafrost in soils, and worked on the photointerpretation of vegetation and terrain. Having begun the study of Quaternary paleoecology in graduate school, Dr. Benninghoff continued throughout his career to be involved with pollen analysis and the reconstruction of vegetation. In the 1960s he invented the technique of adding exotic pollen to sediment samples in order to calculate pollen and spore densities, and was one of the investigators of the famous Cheboygan Bryophyte Bed. During this period he also introduced European phytosociological methods (especially the use of the relevé) to the analysis of Great Lakes vegetation, and published the first computer techniques for the analysis of phytosociological data. His marriage in 1969 to Anne Stevenson joined him with a close companion and partner for his later research and extensive travels.

Another area in which Dr. Benninghoff was internationally respected was polar biology and conservation. In addition to research, he served on numerous boards and committees, and co-authored the 1985 volume *Man's Impact on the Antarctic Environment*. His commitment to conservation was not limited to the polar regions; he lectured and wrote often on the importance of conserving plant species and communities and natural areas. On a visit to Japan in 1971, he was instrumental in saving the 400-year-old Nikko Sugi trees (*Cryptomeria japonica*) from being felled for highway improvement.

His work in pollen analysis led him to consider the behavior and fate of airborne biological particles, and after heading the Aerobiology Theme of the IBP for six years, he founded the International Association for Aerobiology in 1974. He then became interested in the effects of electrical fields on airborne particles, and later extended his study of electrostatics to include processes in soils. Returning to his Alaskan "roots", in 1989 he co-authored a paper on the interactions of electrical potential and freeze-thaw processes.

Besides being an energetic researcher, Dr. Benninghoff was a dedicated and wonderful teacher. He taught for four summers at the U. of Michigan Biological Station in addition to his courses on campus, guided 20 graduate students through to their Ph.D.s, and served on dozens of other dissertation committees, including one for a student in the School of Music. While allowing his students freedom to develop and explore for themselves, he nurtured them with his encouragement and respect, and was always ready to give his help in whatever form it was needed.

Over the course of his career, Dr. Benninghoff reviewed dozens of books for CHOICE, *Science*, and the *Quarterly Review of Biology*. He was a member of numerous professional societies, and led or advised many governmental and scientific boards, commissions, and committees on vegetation, polar biology, and aerobiology. His service activities extended to the state and local level, too, including periods as president of the U.M. Science Research Club and the local chapters of Sigma Xi and the Michigan Botanical Club. He was twice appointed to the Environmental Arts Committee of the Michigan Council for the Arts.

His many awards included the Department of Interior Meritorious Service Award, the Antarctic Service Medal of the U.S., and the Hiroshima University Commemorative Medal for contributions to natural science. In 1990 an anonymous donor enabled the Michigan Chapter of The Nature Conservancy to buy 960 acres in Luce County, part of the watershed of the Two-Hearted River. This marvelous expanse of postglacial dunes, northern mixed forests, swamp, and patterned peatland was dedicated on 8 October 1990 as the Benninghoff Tract. An even "higher" tribute came in 1992, when a peak in Antarctica was named Mt. Benninghoff.

Bill will be remembered and missed not just for his scholarship, but for his love of life. When not engaged in scientific pursuits, he enjoyed playing the piano and attending concerts, especially Gilbert and Sullivan operettas. His gently mischievous sense of humor and appreciation of wordplay can be seen in one of his early publications in the Journal of Glaciology. In it, he described moss polsters on the Matanuska Glacier of alaska, which were tumbled about by meltwater and accumulated concentric layers of mosses and mineral particles. His conclusion: "rolling moss does gather stones!"

Memorial gifts may be sent to the Michigan Chapter of The Nature Conservancy (the Benninghoff Tract), 2840 East Grand River Ave., Suite 5, East Lansing, MI 48823; the Harvard College Fund Memorial Program, 124 Mount Auburn St., Cambridge, MA 02138-5762 (for undergraduate scholarships; make check to "Harvard College Fund Class Endowment" and note "in memory of Dr. William S. Benninghoff"); or The Cranbrook Institute of Science Library (home to the reprint collections of Cowles, Cain, and Benninghoff), Box 801, Bloomfield Hills, MI 48303-0801.

——Barbara J. Madsen

THE BIG TREES OF MICHIGAN
4. Pinus banksiana Lamb.

Elwood B. Ehrle
Dept. of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008

A. Bruce Spike
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Paul W. Thompson[1]
Cranbrook Institute of Science
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Michigan's largest known jack pine grows near the bank of the East Branch of the Escanaba River in Marquette County of Michigan's Upper Peninsula. It is both a State and National Champion tree but may be downgraded by the American Forestry Association due to reduction in crown size and height from the recent loss of several limbs.

Description of the species: Pines are members of the pine family, Pinaceae. The genus *Pinus* is distinguished from other genera of the family growing in Michigan by having its needle-like leaves born in clusters or fascicles, with 2–5 leaves per fascicle. Voss (1972) lists three species of *Pinus* in his *Michigan Flora*. The jack pine can be distinguished from other pines which grow in the state by its leaves, two to a cluster, 1.5–3.0 and occasionally to 6.0 cm long; its cones, less than ten cm long; and by the persistence of its cones, open or closed, on the branches of the tree.

Location of Michigan's Big Tree: Michigan's Champion jack pine is in a remote location in a county-managed forest approximately 16 miles south of Marquette, Michigan, in Sands Township, T45N, R25W, Section 4. The tree can be reached by taking U.S. Route 41 south to the southern edge of the city of Marquette. After turning right onto Genesee Street for one block, turn left onto Division Street (County Road 553), following signs for Sawyer Air Force Base. Drive south on County Road 553 for 15.1 miles and turn right onto a logging road immediately past a snowmobile sign on the west side of County Road 553. Go only 0.2 miles up a slight rise to the second logging road on the left. This road goes through a 10–15 year old jack pine planting, a 1992 jack pine planting, and a 1960 planting of jack pine on the west side of the road and mixed jack and red pine on the east. The road is rough but passable without 4-wheel drive. The road ends in a loop after 1.0 miles.

You then walk approximately 300 yards southwest, downslope, to the bank of the East Branch of the Escanaba River and head upstream about

[1]Deceased 20 September 1994.

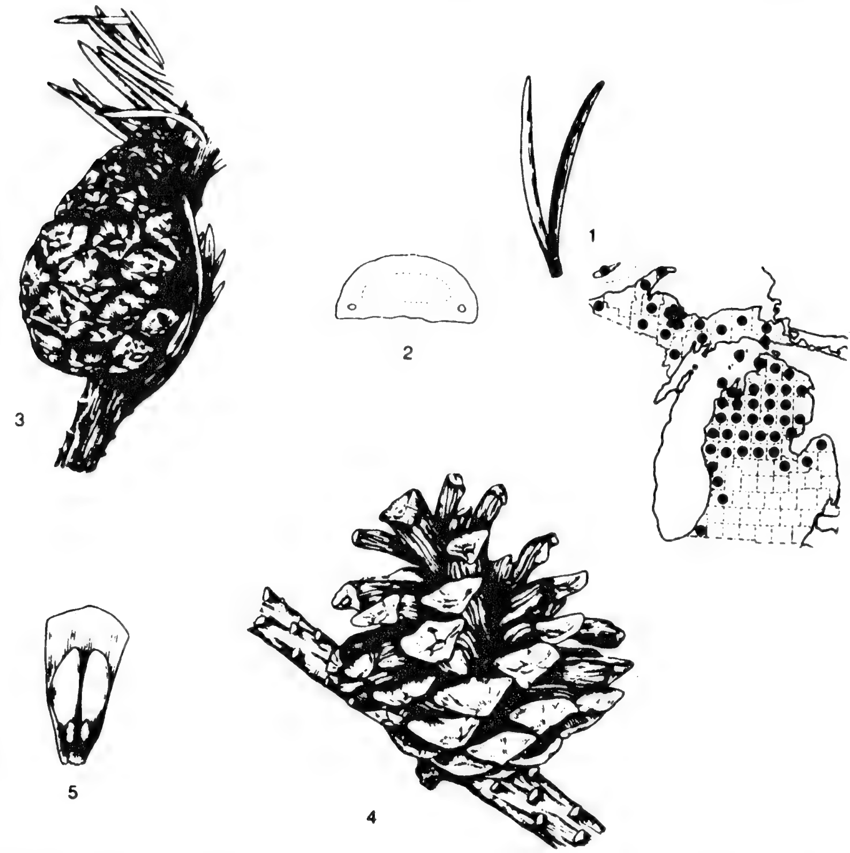

FIGURE 1. Documented distribution in Michigan and characteristics of the jack pine. Map is from Voss (1972). The star indicates the location of Michigan's Big Tree. Drawings are from Barnes & Wagner (1981). 1. Cluster of leaves, ×1; 2. Cross section of leaf, enlarged; 3. Twig with closed cone, ×1; 4. Twig with opened cone, ×1; 5. Cone scale with seeds, ×1.

150 yards. You will pass several large white pines, two of which have girths of 8′3″ (diameter, 30″). The State and National Champion jack pine is 63′ north of the river bank. It has a large burl, 4′9″ above the ground, on the east side of the tree and stands 18′ from a white pine with a 8′2.5″ girth.

Description of Michigan's Big Tree: The tree has a single, healthy trunk. The circumference of the tree at breast height was measured on August 10, 1993 at 92.5″ (235 cm) [Diameter = 29.5″ (75 cm)]. The crown spread was measured at 30′ (9.1 m), a 40% decrease in crown spread compared to that reported by Thompson (1986). The longest branch extends 38′ (11.6 m) toward the river. Even so, the average crown radius is only 15′ (4.6 m). Similarly, the height was measured at 68′ (20.7 m), a decrease of 19% from the 84′ (25.6 m) reported by Thompson (1986). During the intervening years several large branches have been lost. The tree has dead branches two-thirds of the way up but appears to be healthy in its top third. It may be coming toward the end of its natural life span. Since State Champion trees are determined by girth, its State Champion status remains. The reduction in crown size, however, may affect its National Champion status.

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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EDITORIAL NOTICE: LIST OF REVIEWERS

On behalf of Gary Hannan and Richard Rabeler, I wish to thank the following people, who reviewed papers for *The Michigan Botanist* in 1993. The reviewers make possible the high standards maintained by this journal.

Joseph Ammirati
Christopher S. Campbell
Frederick W. Case
Garrett Crow
George Estabrook
Gary Hannan
Neil A. Harriman
Brian Hazlett
William H. Hess
John K. Morton
Gerald Ownbey
Michael Penskar
Jeff H. Rettig
Robert Shaffer
Terry L. Sharik
Welby Smith
Edward G. Voss
Ellen Elliott Weatherbee
Gerould Wilhelm
Dennis W. Woodland

EDITORIAL NOTICES

As many of you already know, I have recently taken over the duties of editor from Rich Rabeler and Gary Hannan. Both of them were feeling increasing pressure from other professional obligations, so they have palmed off—er, bestowed—the position of editor on me. Both continue to be of aid to me as I find my way through the labyrinth of details involved in producing the journal. Rich continues to be especially helpful and supportive (the Herbarium is only two blocks away, so it's easy for me to run over and ask "What do I do about *this*?"). I also have the luxury of advice and assistance from two other former editors, Ed Voss and Howard Crum. Thanks to all of them.

For those of you who don't know me, I am primarily a plant ecologist. My B.A. is from Carleton College, where I was introduced to the joys of botany by William Muir. I spent a year at Cambridge University as a Churchill Scholar, learning Quaternary pollen analysis with John Birks, then came to the University of Michigan, where I completed a Ph.D. in 1987 under the direction of William S. Benninghoff. I spent a few years developing and coteaching an interdisciplinary course at the U.M. Biological Station, and most recently worked on a paleoecological project for the U.S. Fish & Wildlife Service, concerning the development of wetlands in beach ridge-and-swale complexes around Lake Michigan. Peatland ecology and development is my primary specialty, which means that I also get into subjects like bryophytes, sedges, and hydrology.

I look forward to continuing the tradition of quality laid down by my predecessors. Suggestions for improving the journal are always welcome; I can be contacted at the editorial address on the inside front cover or by e-mail: barbara_madsen@um.cc.umich.edu. The *BOTANIST* can use some very direct and concrete help, too: see the other editorial notices in this issue.

——Barbara J. Madsen

EDITOR'S REPORT

Continuing a practice begun by my immediate predecessors, I present some figures on the manuscript flow for *THE MICHIGAN BOTANIST* (as of Sept. 1994).

Manuscripts submitted during 1993: 16
Manuscripts published during 1993: 3
Manuscripts ready to go: 7
Manuscripts in review: 1
Manuscripts rejected: 3
Manuscripts accepted, returned to authors for revision: 2

This is a slight increase in submissions from 1992 (11), which is encouraging. There have been considerable delays, however, in getting some reviews returned, and even more delay in getting revised manuscripts back from authors. These factors are largely responsible for the lateness of this issue of the journal (along with some delay resulting from the change in editors).

The situation outlined in last year's editor's report still holds: we need more papers! There is essentially no backlog of manuscripts, so the journal is in a somewhat unusual position: the more manuscripts we get, the faster they'll get into print! I encourage all of you to send us papers and encourage your friends and colleagues to do likewise.

—Barbara J. Madsen

SEM IDENTIFICATION OF MICHIGAN CATTAILS, *TYPHA LATIFOLIA* AND *TYPHA ANGUSTIFOLIA*, AND THEIR HYBRID, *TYPHA ×GLAUCA*

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INTRODUCTION

Wetlands are among the most productive ecosystems on Earth. As valuable transition zones between terrestrial and aquatic systems, they serve as transformers for many biological and chemical materials. Wetlands are also sources and sinks of resources, perform functions in hydrological and chemical cycles, help prevent floods, cleanse polluted waters and provide habitats for a wide variety of flora and fauna (Good et al. 1978, Mitsch & Gosselink 1986). Maintenance of these valuable ecosystems is essential, and their overall condition may be evaluated by using indicator plant species. As noted by Smith (1987), the hybrid of the broad- and narrow-leaved cattails tends to thrive in unstable wetlands and may, therefore, serve as an indicator of wetland condition.

Three varieties of cattail commonly occur in monospecific or mixed stands in Michigan. They are the broad-leaved cattail, *Typha latifolia* L., the narrow-leaved cattail, *Typha angustifolia* L., and their hybrid, *Typha ×glauca* Godron. A great deal of research on macroscopic cattail morphology has resulted in taxonomic keys for identification of these species and their hybrid (Hotchkiss & Dozier 1947; Fassett & Calhoun 1952; Mason 1957; Smith 1967, 1987; Bayly & O'Neill 1971; Grace & Harrison 1985; Djebrouni & Huon 1988). Although there is substantial overlap in the range of measurements of many of the morphological characters among the three kinds of cattails (Thomkins & Taylor 1983), field identification is usually made by examining the width of leaves and seed heads and the gap distance between the pistillate and staminate flowers. Some researchers claim this gap appears only in the narrow and hybrid plants (Fassett & Calhoun 1952, Grace & Harrison 1986, Djeborouni & Huon 1988) while Hotchkiss and Dozier (1949) and Smith (pers. comm.) state that it does occasionally appear in the broad-leaved cattail as well. Owing to this and to the intermediate nature of the hybrid, accurate identification usually requires more careful examination in the laboratory. Species identification can be made from comparisons of biochemical polymorphisms (Mashburn *et al.* 1977, Sharitz *et al.* 1980), microscopic floral structures, and pollen grains (Hotchkiss & Dozier 1947; Fassett & Calhoun 1952; Mason 1957; Smith 1967, 1987; Grace & Harrison 1985; Djebrouni & Huon 1988). Although floral and pollen characteristics may be the best taxonomic keys for identification, these features are ephemeral. No known studies of leaf epidermal structure have been found in the literature and results of work on seed measurements have been very limited (Grace 1984; Grace & Harrison 1985 who cite Marsh 1962).

The purpose of this study was to expand the microscopic characteristics that can be used as taxonomic tools for determining the identity of cattails when identification cannot be made in the field. These tools will also potentially allow the identification of immature plants that have not produced a flower stalk, those plants that no longer have a seed head, or seeds that are no longer associated with a seed head.

MATERIALS AND METHODS

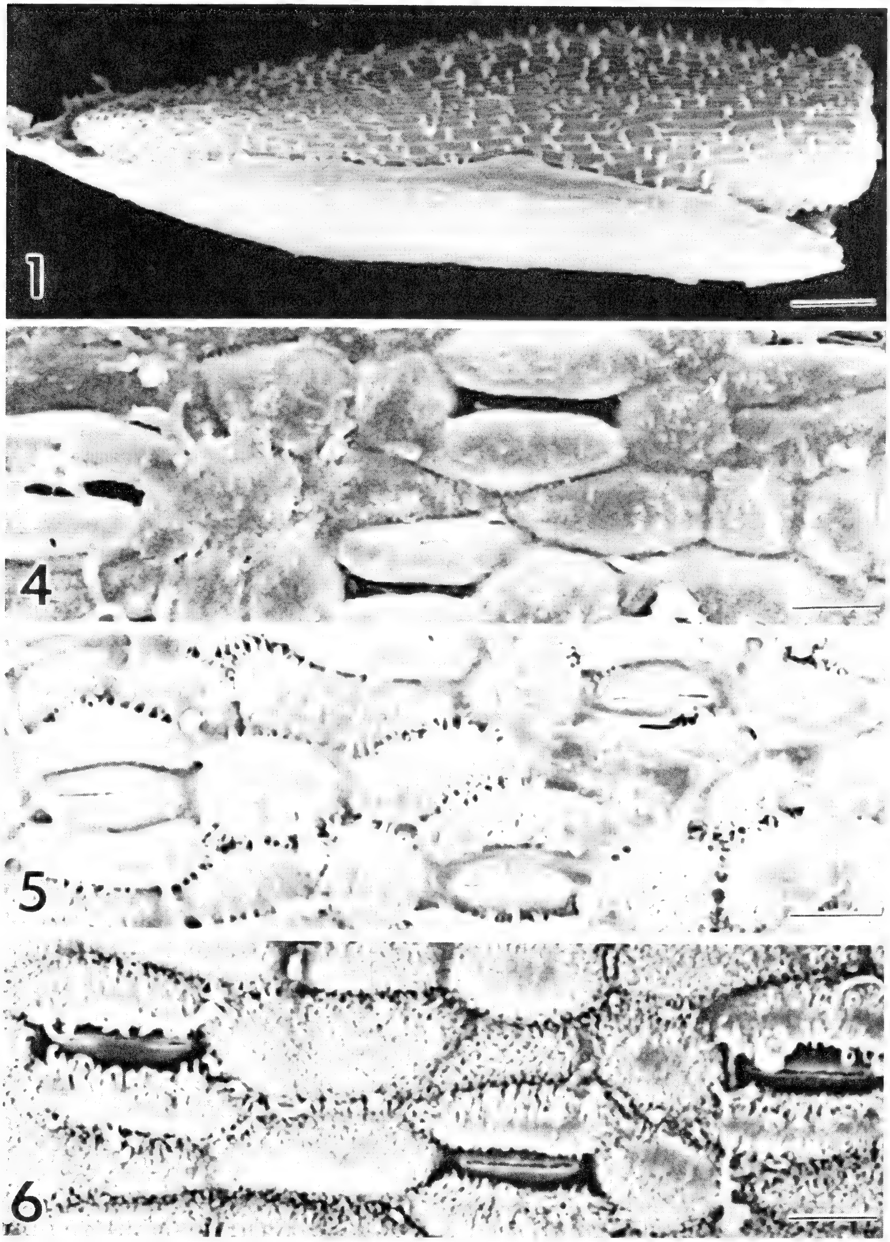
To reduce the likelihood of collecting plants from the same clone, samples of seed heads and leaves of each type of cattail were collected from a total of 17 geographically isolated sites in Washtenaw and Lapeer Counties, Michigan, during September 1992 and again in July 1993. Preliminary identification of cattails was done in the field from gross morphological characters. Once the identity of each plant was verified in the laboratory by examination of microscopic floral characteristics, the samples were prepared for scanning electron microscopy (SEM). Leaf samples were taken from the second leaf below the seed head ($n=6$ for *Typha latifolia*, $n = 11$ for *T. angustifolia*, and $n=6$ for *T. ×glauca*). These leaves were cut approximately 20 cm from the point of attachment and then into 0.5–1.0 cm^2 pieces, vapor fixed with osmium tetroxide overnight and dehydrated in an alcohol series to 100% ethanol. They were then critical point dried, mounted on aluminum stubs with carbon paint and sputter coated with gold. Specimens from this study have been deposited in the Herbarium of Eastern Michigan University.

Seeds were teased away from the stem and individually stripped of their seed coats with microforceps. The seeds were then dehydrated in a 60°C drying oven for 24 hours, mounted on aluminum stubs with double-sided sticky tape and sputter coated with gold. Cattail seeds and leaves were examined using an Amray 1820 I scanning electron microscope.

The length and width of approximately 75 seeds from seven to ten different seed heads of each species were measured after correcting for hysteresis. Means of seed width and length were determined for each plant and these means were then analyzed by ANOVAs. The pair-wise comparisons were made using the Newman-Keuls test for ordered means.

RESULTS AND DISCUSSION

Microscopic examination revealed that the testa of each cattail seed needed to be removed before accurate measurements could be taken. Figure 1 shows the highly reticulated tegmen of a *Typha angustifolia* seed that was revealed after testa removal. Zech and Wujek (1992) found distinct taxonomic differences in tegmen reticulation between the seeds of three species of *Luzula*; however, the tegmen reticulations of seeds examined in this study were similar among the three kinds of cattails. Analysis of seed length data by ANOVA showed that there were significant differences among the three kinds of cattails ($F=31.11$, $P<0.0001$)(Fig. 2). In pair-wise comparisons, seeds of *T. latifolia* were significantly longer than those of *T. ×glauca* ($S_{AB}=0.0335$, $P<0.01$) which were significantly longer than those of *T. angustifolia* ($P<0.01$) (range 1.090–1.820, 0.938–1.510, and 0.732–1.350



FIGURES 1, 4–6. 1. Scanning electron micrograph of a *Typha angustifolia* seed partly enclosed within the outer seed coat. Scale bar represents 100 μm. 4. Scanning electron micrograph of the adaxial leaf surface showing recessed stomata of *Typha angustifolia*. Scale bar represents 10 μm. 5. Scanning electron micrograph showing the adaxial leaf stomata of *Typha latifolia*. Scale bar represents 10 μm. 6. Scanning electron micrograph showing the adaxial leaf stomata of *Typha ×glauca*. Scale bar represents 10 μm.

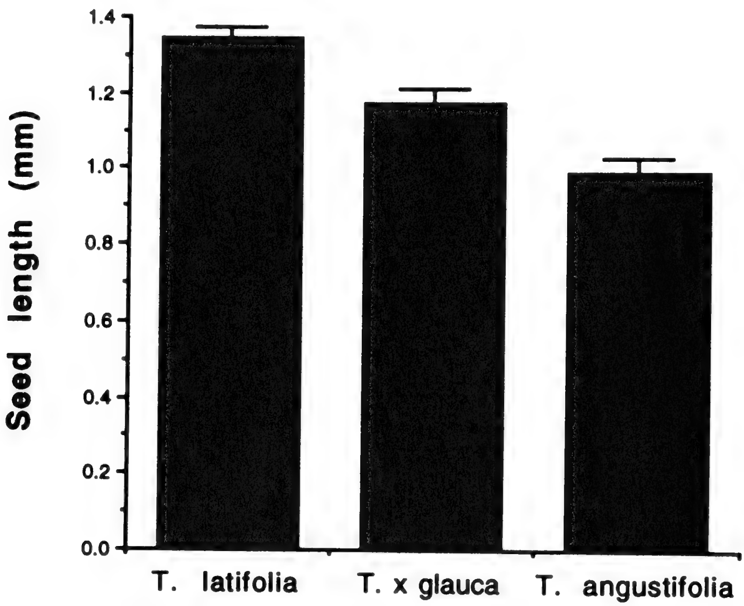


FIGURE 2. Means (± 1 SE) of seed length (mm) for *Typha latifolia* (n = 7 plants), *T. angustifolia* (n = 7 plants), and *T.* ×*glauca* (n = 10 plants). Means were all significantly different (P<.01).

mm respectively). Significant differences in seed width were also revealed by ANOVA (F = 10.11, P<0.001) (Fig. 3). *Typha latifolia* seeds were significantly wider than those of *T.* ×*glauca* (S_{AB} = 0.0069, P<0.01), and those of *T.* ×*glauca* were significantly wider than those of *T. angustifolia* (P< 0.01) (range 0.261–0.381, 0.198–0.400, and 0.202–0.343 mm respectively). Although the amount of variability in hybrid seed width was similar to the parental species, only one hybrid plant produced a few seeds that were narrower than those of either parent. The range of seed lengths of *T. latifolia* measured in this study was greater than that described for *T. latifolia* by Grace (1984). The range of seed lengths of *T. latifolia, T.* ×glauca and *T. angustifolia* reported by Grace and Harrison (1985), citing the unpublished thesis work of March (1962), was not as great as was found in our study. We have been unable to find any published data on cattail seed width with which to compare our findings.

On the basis of our study of cattails from a 2000 mi² area in eastern Michigan, SEM examination of leaf epidermal surface permits differentiation of these three types of cattails from Michigan populations. The guard cells of *Typha angustifolia* are recessed (Fig. 4), whereas the guard cells of *T. latifolia* are clearly visible on the surface of the leaf (Fig. 5). Although the position of the guard cells in the hybrid is intermediate to that of the

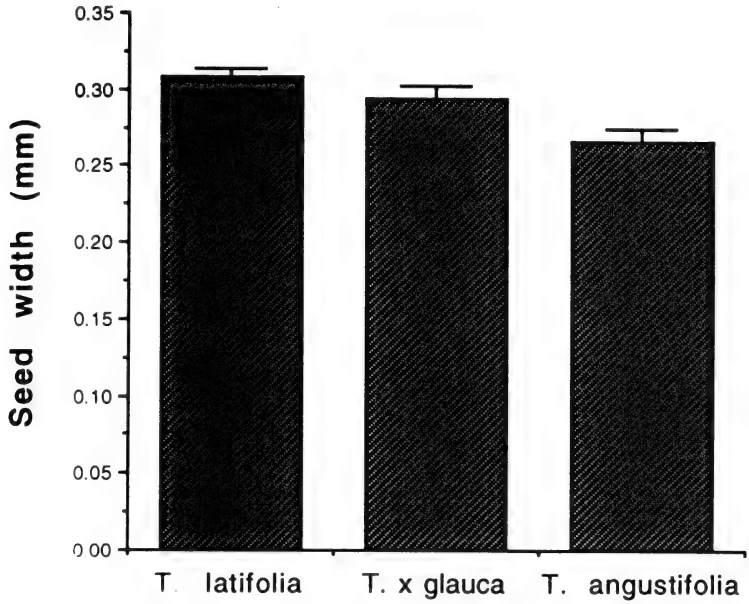


FIGURE 3. Means (± 1 SE) of seed length (mm.) for *Typha latifolia* (n = 7 plants), *T. angustifolia* (n = 7 plants), and *T.* ×*glauca* (n = 10 plants). Means were all significantly different (P<.01).

parental cattails, this is a discrete morphological characteristic in which there is no overlap with either parent (Fig.6).

These microscopic data confirm macroscopic findings (Hotchkiss & Dozier 1947; Fassett & Calhoun 1952; Mason 1957; Smith 1967, 1987). That is, it is evident that the characteristics of *Typha* ×*glauca* are intermediate between those of the two parents. Although the means of seed measurements were significantly different among the three kinds of cattails, their use as a taxonomic character is not 100% reliable, because of the overlap between cattail types in these measurements. However, this study has elucidated a new diagnostic tool for cattail identification that appears very reliable when applied to Michigan populations. When other characteristics such as pollen and flowers are not available, stomatal position extends our ability to differentiate species.

Dependable identification of cattail species, no longer temporally limited, can reveal important changes in the local ecology. As previously noted, *Typha* ×*glauca* grows successfully in very unstable wetlands, occupying an ecological niche that neither of the two parental species can fill (Smith 1987). Thus the appearance of hybrid plants may be used as indicators of disturbance and, perhaps, of wetland health. To test the robustness of our findings, leaves and seeds collected throughout the geographic ranges of these three species will be examined in future studies.

SUMMARY

Scanning electron microscopic measures of seeds as well as SEM comparisons of leaves of three kinds of cattails revealed distinct differences in cattails collected in Michigan. *Typha latifolia* seeds were significantly longer and wider than those of the hybrid *T.* ×*glauca*, which in turn were significantly longer and wider than those of *T. angustifolia*. Examination of leaf epidermis revealed that the positions of stomata and primary guard cells can be used as a diagnostic characteristic with which to separate the three kinds of cattails.

ACKNOWLEDGMENTS

This work was supported in part by NSF grant #DEB-9307012 and the Meta Hellwig Apprenticeship Fund of the Biology Department, Eastern Michigan University. We greatly appreciate the assistance of Dr. Gary Hannan for examination of data, Dr. Robert Neely for the use of his resources, and Dr. Catherine Bach for invaluable critical reviews of this manuscript. Also, thank you to Jerry Hartenburg for technical assistance.

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REVIEW

PIONEERING WITH WILDFLOWERS. George D. Aiken. 145 pages, paperback; approx. 17 May 1994. Alan C. Hood & Company, Inc., 28 Birge Street, Brattleboro, Vermont 05301; $12.95 + $2.50 postage and handling.

George David Aiken, 1892–1984, graduated from high school in 1909; he was a school director for the town of Putney, Vermont, 1920–1937; he served in the State House of Representatives, 1930–1934, the last two years as Speaker of the House, then as Lt. Governor 1935–1937; he is best remembered as Governor of Vermont (1937–1941) and as a six-term U.S. Senator from Vermont, 1941–1975. (Biographical data are drawn from cover four of the book plus *Who's Who in America* for 1944, to make the point that the author has no formal training in Botany.)

For many years prior to his attaining political prominence, Aiken was a nurseryman in Vermont, specializing in the propagation and cultivation of ferns and wildflowers. The nursery, Putney Nursery, Putney, Vermont 05346, still exists; cover one is graced by nine color photographs of five species of perennial wildflowers raised by Senator Aiken and still thriving in the garden there.

In response to a great many questions from his customers, Aiken wrote this book in 1933. The work went through three or four editions (it is not clear from the publisher's blurbs). The current (5th?) edition is a verbatim reprint of the 1933 prose, with a number of line drawings by Marion Satterlee replacing photographs in the original; photographs likewise were included in some of the later editions, as I learned from reviews of earlier editions, helpfully supplied by the publisher.

The coverage of the book is very extensive, *Aconitum* to *Zizia*, well over 200 species, plus 36 fern species (but no fern allies are mentioned). The species are predominantly those of the Gray's Manual range. One of the author's concerns at the time he wrote the book was that species were being wiped out in the wild, and that artificial propagation would avert this. In the present edition, the publisher has most wisely and responsibly inserted warnings about laws to protect wildflowers; in the two-page foreword by Henry W. Art, these warnings and admonitions are repeated, along with reference to a directory of reputable wildflower nurseries, published by the New England Wildflower Society, 180 Hemenway Road, Framingham, MA 01701.

"The nomenclature used in this book is according to 'Standardized Plant Names' as they were in 1933. Changes in the scientific names are shown in the index after the word 'now'" (page 135). And there's the rub. Some of the names will send you back to earlier editions of Gray's Manual, and some are just plain imaginary (*Aster linnaeafolia*, page 120, is not in Index Kewensis; I suspect it may be a misprint for *Aster linariifolius*). This also illustrates the point that the author sees no reason to have adjectival epithets agree in gender with the generic name; there are numerous examples of such grammatical slips throughout. *Trillium sessile californicum* on page 40 (what's meant is *Trillium sessile* L. var. *californicum* S. Watson) is not to be found in any flora at hand published in the last forty years. Somebody has to tell me it is *Trillium chloropetalum* (Torrey) Howell in modern works, if I am to find it in a dealer's catalog. If the motive is to re-publish a botanical classic, warts and all, then do so, original photographs and all. If the motive is to make an excellent wildflower book available to a new reading public, then it needs to be critically edited in matters of botanical nomenclature.

The nomenclaturally garbled references to our two species of *Polygonatum* (Liliaceae; page 67) are one more example of the necessity for a sharp editorial pencil; the Latin names are quite at variance with modern usage, though the prose is every bit as applicable as it was in 1933.

The four indexes are very thorough, but with their own oddities. For example, for each species of *Aster*, there is a reference to page 14, where only *Aster* in a generic sense is mentioned—nonetheless helpful, because the comment there is applicable to all the asters. Somebody has made a few corrections in the scientific names index—there is no clue who is responsible—but there are dozens more needed. The interested gardener will want to look up plants in this book by the common name: e.g. Culvers-Root will lead you to page 78; if you look for *Veronicastrum virginicum*, your search will be in vain, unless you already know it was *Veronica virginica* back in '33. If you want to find out something about Ostrich Fern, look it up that way; if you know it was called *Pteretis nodulosa* in the older manuals, then you will find that, along with the information that it is now *Matteuccia struthiopteris*, but there's no alphabetical entry for *Matteuccia*.

Nobody will suppose this book is a technical botany reference (I have no idea what a root stalk in a fern is, but I suspect rootstock or rhizome is meant); for many, its charm lies in the gentle flow of the language and the numerous hints on cultivation, derived from many years of practical experience. I dimly recollect that Senator Aiken was a white-haired gentleman with wire-rimmed glasses; how fitting it would have been to have included a photograph of the author.

——Neil A. Harriman
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Photographed by H.A. Crum

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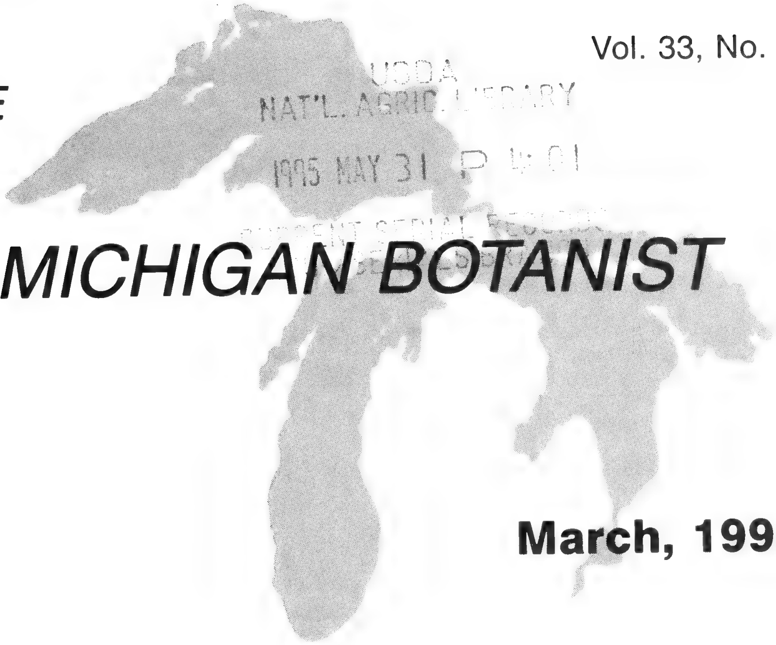

THE MICHIGAN BOTANIST

March, 1994

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DISTRIBUTION, HABITAT AND CONSERVATION OF *VIOLA NOVAE-ANGLIAE*

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ABSTRACT

Viola novae-angliae House occurs in the Great Lakes region, New England, and one site in northeastern New York, and is a candidate for federal listing under the Endangered Species Act. To clarify current distribution, ecology, and possible endangerment of this species, we reviewed data from herbarium specimens and recent field surveys. We conducted field searches to relocate historic localities and discover new sites in the northwestern Great Lakes region and New England. The violet proved to be locally common in northern Minnesota, and in both Minnesota and Wisconsin was the characteristic violet of open, xeric rock and sand substrates, in natural settings and artificially disturbed areas such as road cuts through granite knobs. In Maine as well as in Minnesota and Wisconsin, the violet was found in both historical and new sites. Maine populations are restricted to rocky, circumneutral limestone riverbanks. Density and frequency of plants, flowering, and fruiting are highest where canopy cover and leaf litter are lowest, suggesting that population growth may be constrained by competitive reduction in individual above-ground growth and/or seedling establishment.

Viola novae-angliae is restricted to a comparatively small range and is rare (especially in the east) to locally common (in the west). It is verified from approximately 91 recently collected (and presumed extant) sites, with a total of 139 historic locations thus far known. The number and distribution of verified locations and the large population sizes make it secure at both national and regional levels. We recommend removing the violet from consideration for federal listing in the United States and Canada. We further suggest delisting it in Minnesota and Wisconsin, but listing it at various rarity levels where it is less common in the remaining states and provinces. Appropriate management on publicly owned sites in the Great Lakes region and conservation of the privately owned rivershore habitats in the northeastern states and provinces will be important in maintaining the viability of this species across its range.

INTRODUCTION

In 1904 H. D. House described *Viola novae-angliae* (front cover) from specimens collected on a sandy shore in Aroostook County, Maine. Brainerd (1905, 1921) later expanded House's original description with data from fruiting plants and reported additional localities for the violet in New England and the northwestern Great Lakes region. Until recently, amateur taxonomists and violet specialists followed Brainerd. In a revisionary treatment of acaulescent blue violets for North America, McKinney (1991) reduced the taxon without comment to a variety under *V. sororia* Willd. In the second edition of their manual of northeastern vascular plants, Gleason and Cronquist (1991) submerged *V. novae-angliae* under *V. sororia*, merely noting it as a sagittate-leaved form. In this report we maintain the violet at the species level because the two possess a number of consistent morphological distinctions in flowers, capsules and leaves and are ecologically isolated as described in habitat observations below.

Regional manuals (Fernald 1950, Gleason & Cronquist 1963, Scoggan 1978) echo the original reports of the violet's distribution from extreme northeastern United States and adjacent Canada (Maine and adjacent New Brunswick) and the northwestern Great Lakes region (Michigan, Minnesota, Wisconsin and adjacent Ontario). Its habitats have been described as cool, rocky riverbanks, sandy lakeshores, and xeric forests near water. Based on its restricted range and apparent rarity, the species has been recommended for evaluation for listing as "Category 2" under the Endangered Species Act by the Department of Interior. The U.S. Forest Service has also included *V. novae-angliae* on their list of sensitive species for purposes of biodiversity management and conservation. Most of the states or provinces in which it occurs also list it as Endangered, Threatened, or Special Concern.

Following a contract study conducted by Ballard for the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources, we combined field observations from extensive surveys and compiled verified records from many herbaria to elucidate the status of *V. novae-angliae* in the Great Lakes and New England/maritime regions of North America. Our summary of the updated information concerning *V. novae-angliae* aims to clarify its current distribution, ecology and degree of endangerment in North America.

METHODS

Herbarium specimens matching the type description of *V. novae-angliae* were examined at MICH and MSC for distinguishing characters, locality and habitat data. (Herbarium abbreviations follow Holmgren et al. [1990]). Morphological characters determined to be diagnostic for *V. novae-angliae* in contrast with other acaulescent blue violets in the northeastern United States and Canada include an unlobed, narrowly ovate-triangular leaf blade outline; sparsely to densely villous foliage; lance-ovate sepals with rounded apex; short sepal auricles; short-ovoid and heavily purple-flecked capsules; and prostrate or arching peduncles subtending the cleistogamous capsules.

Field surveys in the western Great Lakes region (Michigan, Minnesota, and Wisconsin) were based on records for *V. novae-angliae* from state Natural Heritage Programs (in their respective Departments of Natural Resources) plotted onto 1:250,000 scale topographic maps encompassing northwestern Michigan, northern Wisconsin, and northeastern Minnesota. Ballard searched for flowering *V. novae-angliae* May 22-June 1, 1988. During the field circuit, he visited DUL, MIN and WIS to confirm specimens of *V. novae-angliae*, also checking specimens of taxa likely to be confused with the species. A search for fruiting plants from August 6–24 of the same year covered largely the same route as the spring trip, including revisits to certain sites. Field searches focused on readily accessible historic locations and potential new sites in areas lacking historic records. Relatively inaccessible localities in the Boundary Waters area of northeastern Minnesota and adjacent Ontario were not visited. Searches ran 1/2 to 3 hours per site, depending on the extent of suitable habitat and accessibility of the site. Independent of field surveys, we examined herbarium specimens (or photocopies of them) from AM, DAO, GH, LKHD, ME, NEBC, MT, NBM, NYS, OSH, TRT, US, UWGB, UWSP, and Kathryn Rill in Oshkosh, Wisconsin.

For Maine surveys, label data from specimens at GH, MAINE, NEBC, and NHA identified as *V. novae-angliae* served as the basis for field investigations. Gawler and other botanists visited historic sites and additional potential habitats from 1981–1990 as part of an ongoing statewide survey for high priority rare plant species.

In total, we searched 19 sites (7 historic and 12 *de novo*) in Maine; 3 sites (1 historic and 2 *de novo*) in Michigan; 42 sites (7 historic and 35 *de novo*) in Minnesota; and 13 (3 historic and 10 *de novo*) in Wisconsin. For each location where the species was found, data were recorded on Heritage Program field forms for site and habitat conditions, population conditions, and fecundity. Vouchers for certain new and relocated sites were later deposited at MAINE, MICH, MIN, and WIS.

RESULTS AND DISCUSSION

Distribution. Field searches by the authors confirmed *V. novae-angliae* at four of seven historic locations and three of twelve potential new locations searched in Maine, two of seven historic locations and nine of 35 potential new locations searched in Minnesota, and one of three historic locations and one of 10 potential new locations searched in Wisconsin. The three brief searches for the species in Michigan were unsuccessful. In Maine, *V. novae-angliae* was reported by other botanists from an additional seven of the 12 potential new areas searched. These locations remain unverified, as no specimens were collected (in most cases, the population sizes were very small). In many instances, searches for historic localities were unsuccessful owing to the vagueness of locality data on herbarium specimens or the locally extensive available habitat (hampering surveys for a possibly localized species in a limited amount of time). In such localities, the violet is quite likely to remain even though we lacked the time to find it. At any rate, successful field surveys showed the violet to be locally frequent but rarely abundant along rocky banks of the St. John and Penobscot River systems in Maine, locally common and widespread in a variety of sites in northern Minnesota, and infrequent but widespread over the northern half of Wisconsin.

Examinations of collections of *V. novae-angliae* and taxa confused with it, and inclusion of collections resulting from field work in 1988 and later years, resulted in a total of 235 verified specimens. In many cases, several specimens appeared to be from the same or semi-contiguous sites; these were consequently grouped together as a single location. We thus determined the specimens to represent approximately 139 distinct historic populations of *V. novae-angliae*. These verified localities were distributed as follows: 1 in Manitoba, 2 in New Brunswick, 18 in Ontario, 14 in Maine, 7 in Michigan, 64 in Minnesota, 1 in New York, and 32 in Wisconsin. Verified locations supported by voucher specimens are cited in full in the Appendix.

Field and herbarium studies support the bimodal distribution reported previously for *V. novae-angliae*, with the northwestern Great Lakes region harboring the bulk of known localities, but with the species also well represented along portions of the St. John and Penobscot River systems in Maine and a few other locations in the northeast (Fig. 1). The presently known distribution leads us to suspect that intensive searches of appropriate sites in southeastern Manitoba, eastern Ontario, northwestern Michigan, northern

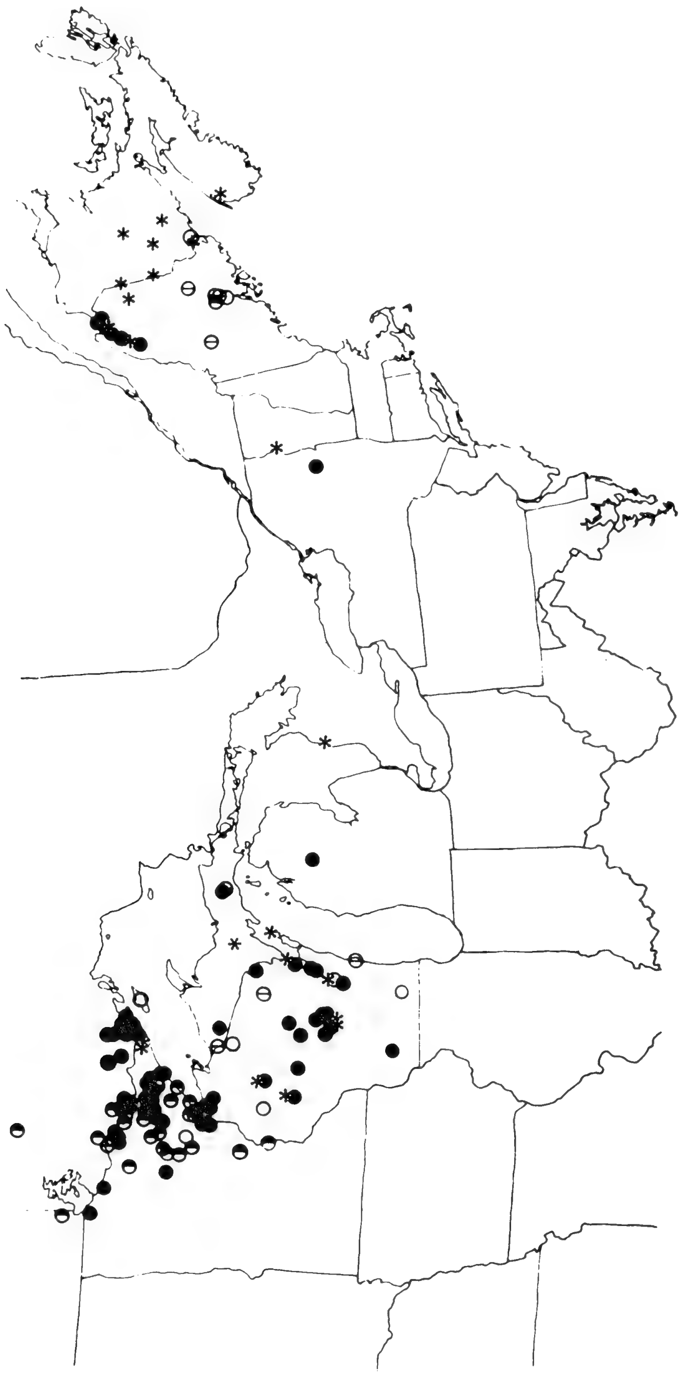


FIGURE 1. North American range of *V. novae-angliae*; asterisk = unverified literature report or unvouchered sighting; closed circle = vouchered collection, 1965–1993; half-closed circle = vouchered, 1940–1964; open circle with line = vouchered, 1915–1939; open circle = vouchered, before 1915. In many instances, one circle represents two or more proximal populations vouchered during same time period.

New York, Vermont, New Hampshire, Quebec and New Brunswick might turn up new populations of the species. Recent surveys for local flora projects by other botanists have revealed several new locations in poorly represented areas of the range of *V. novae-angliae*. These include a collection near Superior, Wisconsin; an Upper Peninsula station near Lake Gogebic in Michigan; populations around Camp Grayling Military Reservation in Michigan's Lower Peninsula; and a southwestern range extension in Iowa County, Wisconsin.

Additional unconfirmed localities require verification. Specimens representing five and three localities, respectively, by the Wisconsin and Minnesota Heritage Programs, could not be found in recent herbarium searches. In addition, eight sight reports by the Maine Natural Heritage Program and eighteen new sites noted by Kawishiwi Forest Ranger District in northeastern Minnesota are unvouchered. We have been unable to locate vouchers for several literature records, including Brainerd's (1921) reports from Parry Sound, Ontario, and Wild Rose and Saxeville, Wisconsin; Brainerd's (1921) reference to a collection from Bear Lake, Nova Scotia; all but two localities mapped by Hinds (1986) for New Brunswick; and Pease's (1964) report from Shelburne, New Hampshire (Garrett Crow, pers. comm.). A southern Wisconsin collection labelled "Whitewater" (*Sykes s.n.*, 19 May 1882, WIS) was previously far enough south of the range delimited by all other records that the record was initially disregarded as a labelling error, until the Iowa County, Wisconsin discovery was made.

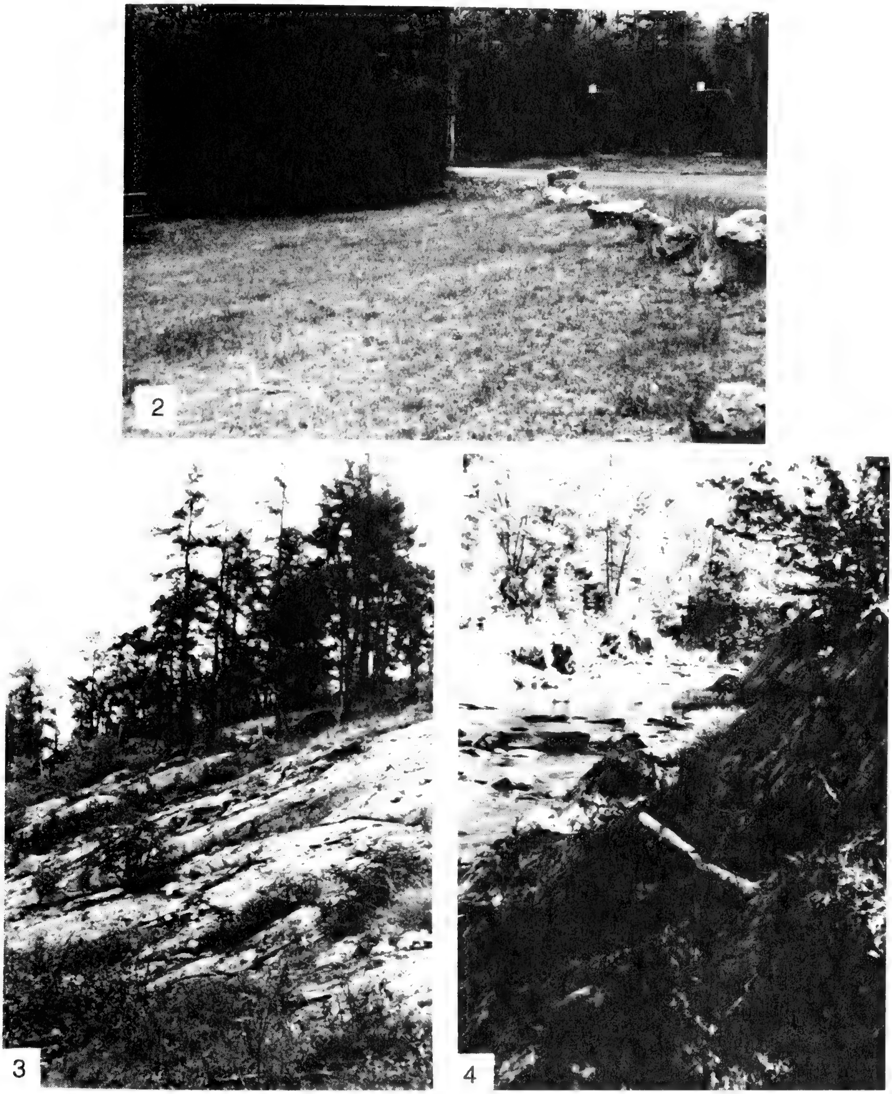
The distribution of *Viola novae-angliae* mirrors that of several other herbaceous perennials whose ranges are nearly or entirely confined to the region north of the Wisconsinan glacial boundary. These include Great Lakes endemics as well as others, e.g., *Botrychium mormo* W. H. Wagner and *B. rugulosum* W. H. Wagner, *Carex heleonastes* Ehrh. ex L. f., *Scirpus clintonii* Gray, *Iris lacustris* Nutt., *Cirsium pitcheri* Nutt. and *Prenanthes racemosa* Michx. (see Argus et al. 1982–1987). Based on macromorphology, distribution and habitat, *V. novae-angliae* may represent a derivative of hybridization between *V. sagittata* Aiton and *V. sororia* which differentiated into its present state following invasion of the ecologically open habitats left as the Pleistocene glaciers receded, probably south of the line of glaciation rather than from an unlikely refugium such as the "Driftless Area" (Cochrane & Salamun 1974, Hartley 1962).

Habitat. Throughout its range, *V. novae-angliae* typically inhabits xeric microsites subject to natural or artificial disturbance, often adjacent to water or wetlands (Table 1). In Minnesota, populations were located quickly by searching the tops of granite knobs or the ground surrounding their bases. Certain areas of the state comprise extensive mosaics of granite knobs separated by wetlands; here, the violet was found on nearly every granite knob searched. Roadside ditches and banks at the bases of granite knobs, powerlines passing over the knobs, fallow meadows, and mowed "lawns" and gravel roads in campgrounds (Fig. 2) next to rock-bottomed rivers were also predictable habitats for the violet.

The natural setting of the violet was typically a xeric rock substrate,

TABLE 1: Site and population characteristics for some representative *Viola novae-angliae* localities.

State/Province Site Name	Pop. #	Site Description	Associates
MINNESOTA			
St. Louis River Gorge	100+	bank above river shore, thin, slightly moist, loamy, sand over bedrock	*Geum*, *Fragaria virginiana*, *Poa compressa*, *Equisetum arvense*, *Fraxinus pennsylvanica*, *Rosa acicularis*, *Luzula acuminata*, *Carex pensylvanica*, *Galium boreale*, *Aster macrophyllus*
Shagawa Lake	1000+	fallow pasture (abundant), thin loamy sand over bedrock, next to dry northern forest (scattered) on bedrock	*Poa compressa*, *Achillea millefolium*, *Rubus*, *Taraxacum officinale*, *Fragaria virginiana* (pasture); *Vicia americana*, *Mentha arvensis*, *Chrysanthemum leucanthemum*, *Danthonia spicata*, *Betula papyrifera*, *Abies balsamea*, *Vaccinium angustifolium* (forest)
Finland State Forest Campground	150	thin heavy clay/gravel over bedrock, in artificial clearing for campsites adjacent to Baptism River	*Taraxacum officinale*, *Trifolium pratense*, *Fragaria virginiana*, *Aster macrophyllus*, *Ranunculus acris*, *Poa compressa*
Ash Lake	30	thin loamy sand topping granite knob, under selectively logged dry northern forest	*Diervilla lonicera*, *Corylus cornuta*, *Pteridium aquilinum*, *Fragaria virginiana*, *Aster macrophyllus*, *Picea glauca*, *Pinus resinosa*, *Populus* spp.
WISCONSIN			
Pine River Dells	25	near vertical scarp bordering river, and nearby flat gravel/sand bank	*Campanula rotundifolia*, *Danthonia spicata*, *Solidago hispida*
MAINE			
Twin Brooks Ledges	250	circumneutral slate ledges along Allagash River, mostly dry but locally seepy	*Campanula rotundifolia*, *Allium schoenoprasum*, *Trisetum spicatum*, *Fragaria virginiana*, *Primula mistassinica*, *Tofieldia glutinosa*
Veazie Ledges	20–40	dry circumneutral metasedimentary ledges along Penobscot River	*Campanula rotundifolia*, *Erigeron hyssopifolia*, *Hedyotis longifolia*, *Allium schoenoprasum*, *Senecio pauperculus*, *Solidago* spp.



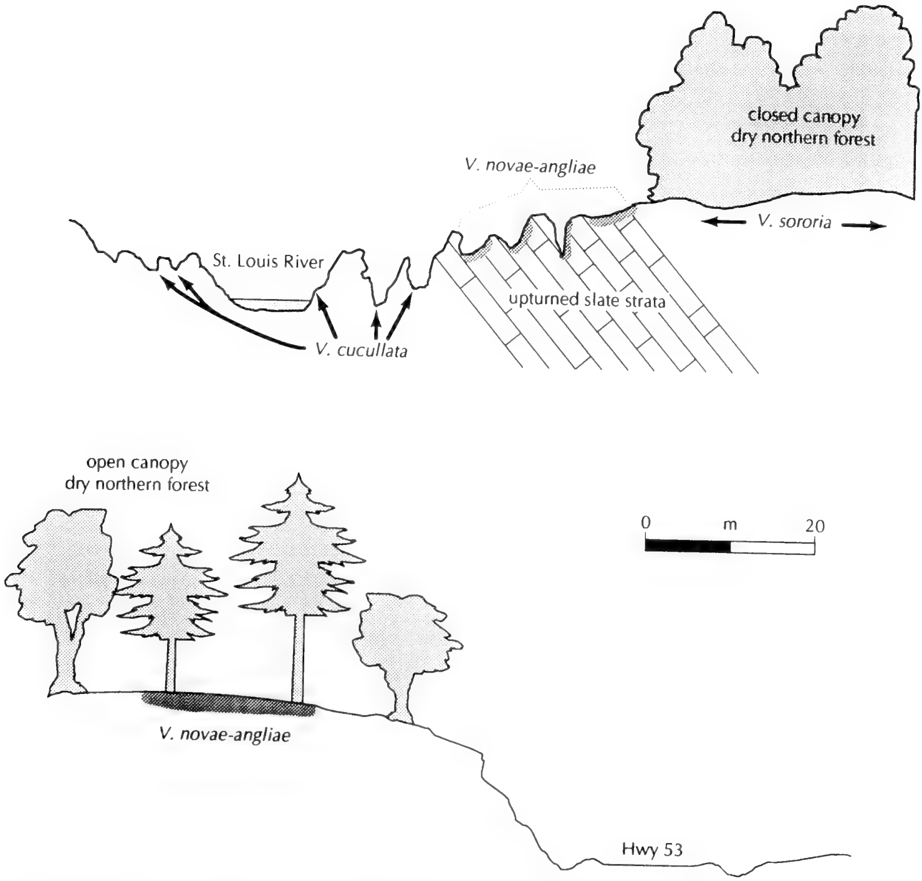
FIGURES 2–4. Natural and human-created habitats occupied by *V. novae-angliae*: (2) lawn adjacent to rocky riverbank at Finland State Forest Campground, MN; (3) large granite knob south of Ely, MN; (4) rock outcrops of Pine River Dells, WI.

sometimes steeply inclined and oriented south or west, without canopy or with a partial one of hardwoods and conifers (Fig. 3). In certain areas, particularly at the south edge of its Minnesota range, the violet sometimes occurred in sand or, rarely, clay overlying bedrock. Substrate moisture, as interpreted by handling of soil surrounding the rhizomes, was usually very low. Dry soils were found both at sites removed from water and those near active bodies of water, such as lakes and rock-bottomed streams or rivers, where ice scouring or wave action from high spring water levels commonly swept away soil deposits capping the bedrock elsewhere (Fig. 4). Over the rest of the growing season, local substrate conditions became increasingly droughty. Consequently, though the violet was usually found near water, its occurrence there was not correlated with moist substrate conditions *per se* but with predominantly droughty, exposed substrates.

In Minnesota, the species occurred in a variety of settings including rocky river banks, rock lakeshores, granite knobs surrounded by sedge meadows, and extensive sand plains with open hardwood-conifer forest. Associated vascular plant species indicated a substrate with acidic or circumneutral pH (Table 1). Populations in Wisconsin, while found in a diversity of habitats as in Minnesota, were predominantly along river systems; the microhabitat conditions of these sites paralleled those in Minnesota in terms of moisture, substrate, and light. The Iowa County, Wisconsin population is one of the few in the Great Lakes region that occupied an apparently calcareous substrate (as judged by associated vegetation). The Wisconsin population grew near the bottom of a limy prairie on a steep south-facing slope, under conditions roughly comparable to limestone ledge populations in New England and New York state.

In Maine, populations were found only along rocky river banks. The species is most characteristic on vertically-fissured slatey ledges, though occasionally found on sandy or gravelly river-beaches. Most habitats lack woody vegetation and support only sparse herbaceous vegetation, owing to annual flooding and/or ice-scouring. As in the Great Lakes habitats, substrates are xeric. However, whereas the substrates of nearly all western Great Lakes populations were interpreted to be acidic or circumneutral granite, Maine populations were believed to be only on circumneutral or calcareous limestone substrates, and were associated with known calciphiles such as *Carex hassei* Bailey, *Hedyotis longifolia* (Gaertner) Hook., *Erigeron hyssopifolius* Michx., *Primula mistassinica* Michx., and *Potentilla fruticosa* L.

Substrate pH in itself, as inferred from living populations of *V. novae-angliae* in the western Great Lakes region and Maine, did not appear to limit the local distribution of the violet, while substrate moisture, canopy cover, and competition with other vegetation have a clear impact. These observations led us to reject one botanist's suggestion that the species may have undergone ecotypic differentiation with regard to substrate pH in the two regions of its continental range. It seems more likely that the occurrence of *V. novae-angliae* on substrates with distinctly different pH expressions in the two regions is incidental. The Maine distribution may be determined more by disturbance regime than by substrate pH.



FIGURES 5–6. Cross-section of representative sites in Minnesota showing local distributions of *V. novae-angliae*, *V. cucullata*, and *V. sororia*: (5) St. Louis River Gorge, (6) Ash Lake.

Although *V. novae-angliae* is the characteristic acaulescent blue violet of droughty, exposed rock and sand substrates in the northwestern Great Lakes region, it was not as commonly encountered in the field as *V. cucullata* Aiton and *V. sororia* Willd. *sensu lato*, two common acaulescent blue violets sympatric with it in the northeastern United States and Canada. Its lower relative frequency corresponded with the restricted distribution of suitable substrate and disturbance conditions. To contrast particulars of plant distribution with respect to habitat at a local scale in *V. novae-angliae* and its closest relatives in the region, Figures 5 and 6 show distributions of *V. novae-angliae*, *V. cucullata* and *V. sororia* in two different types of sites in northeastern Minnesota. The typical location of *V. novae-angliae* in xeric sites with the greatest substrate exposure and least competition with shade-tolerant native vegetation is well illustrated. Both *V. cucullata* and *V. sororia* were often found in significant numbers throughout areas with comparatively heavy densities of native shade-tolerant vegetation, or under dense canopy cover. The former species thrived characteristically in very moist to saturated substrates, while the latter reached its highest frequency in dry-mesic to mesic substrates.

Field observations suggested that plant density in *V. novae-angliae* is relatively low in natural settings, with plants scattered singly throughout an area of apparently uniform habitat. The number of individuals at a site was occasionally in the thousands (particularly in Minnesota), but more often was less than 100. In Maine, for example, of the sites for which we have population estimates, three supported 100–500 plants, three supported 20–40 plants, and four supported fewer than ten plants. Density was highest in sites where extensive disturbance (natural or artificial) or extreme edaphic conditions maintained large areas of exposed rock or sand substrate, reduced canopy cover, and minimal groundlayer vegetation. Flowering was similarly correlated with reduced canopy cover, with the greatest incidence in plants regularly exposed to sunlight.

The violet's intolerance of heavy canopy cover and groundlayer vegetation, particularly in Minnesota, was further demonstrated by its rarity in sites where timber management favored high proportions of pines, particularly red pine (*Pinus resinosa*). In sites where individuals of *V. novae-angliae* were found at all, the plants typically produced long, spindly petioles, distinctly yellowed leaves, and few flowers. In unmanaged tracts next to these managed sites, individuals were often found, and these appeared in all respects to be healthy and vigorous.

Protection Status. Field and herbarium studies have demonstrated that *V. novae-angliae* is widespread in the northwestern Great Lakes and New England/maritime regions. The violet is especially common in the western portion of its range, with the majority of its verified localities in Minnesota. It is restricted to the southwestern portion of western Ontario but is frequent there. In Wisconsin it is widespread and infrequent. In Michigan and Manitoba it is known from very few localities, and its status is not clear. It is worth noting that, in 1991 and 1992, botanists found populations in Michigan's western Upper Peninsula and northern Lower Peninsula, northernmost and southwesternmost Wisconsin, and even more in northeastern Minnesota.

In the eastern portion of its range it is known or reported from dozens of localities, but in New York it is very poorly represented although potentially undercollected. Its absence from Vermont, New Hampshire and Quebec, where one might imagine suitable habitat (e.g., along the headwaters of the Connecticut River), is mystifying. Nevertheless, the number of recently verified sites (Table 2) indicates that the species is well represented overall at both ends of its range.

Populations in most areas appear to be relatively persistent over long periods, except where intensive timber management changes habitat conditions dramatically. Where the forest landscape is vast and presumably still

TABLE 2: Population numbers and conservation status of *V. novae-angliae* by state and province.

	MI	MN	WI	Man.	Ont.	ME	NY	N.B.	TOTAL
NUMBER OF LOCATIONS[1]									
historic (not recently confirmed)	2	28	9	0	1	7	0	1	48
confirmed extant	5	36	23	1	17	7	1	1	91
# extant in public ownership	4	28	2	0	4	0	0	0	38
total localities	7	64	32	1	18	14	1	2	139
EST. INDIVIDUALS[2]	140	2610	770	20	340	2000	20	20	5830
CONSERVATION STATUS[3]									
current status	T	SC	T	none	none	SC	E	none	
proposed status	T	delist	delist	T	none	SC	E	E	

[1]Confirmed extant locations are represented in most cases by specimens collected in 1965 or later; for locations in the remote Boundary Waters region of Minnesota and Ontario, and the Manitoba site, specimens as old as 1940 are accepted as presumed extant.
[2]Estimated population numbers compiled for each state or province are based on actual counts or estimates and, for the many populations lacking data, assume an arbitrary 20-plant size; the numbers are likely gross underestimates especially for MN, Ont. and WI, and provide only an order of magnitude comparison among states and provinces.
[3]Status: E = endangered, T = threatened, SC = special concern.

subject to such natural processes as occasional fire and windthrow, such as the more remote areas of Minnesota, Ontario, and Wisconsin, the violet will likely remain a stable, significant component of the dry forest/bedrock landscape. In the New England/maritime region, nearly all populations are small, and restricted to linear exposures of bedrock along river systems. Nevertheless, populations of scattered individuals are distributed intermittently along these corridors, and collections nearly a century old indicate the populations can persist. As long as ice-scouring and other natural processes that maintain these natural river corridors in their present condition continue, *V. novae-angliae* populations will likely persist sporadically, albeit in a linear distribution, across a relatively large area.

The occurrence of the violet in a variety of sites, all of which possess a particular ensemble of habitat conditions, and the fact that it is characteristically replaced by other allied species where conditions change across the landscape, suggest that *V. novae-angliae* is genetically adapted to its narrow habitat conditions. Its elimination or reduction to small numbers, with lower rates of flowering and fruiting, where suitable conditions have been diminished by the cessation of natural processes or by adverse human manipulation is of particular management interest. Those involved in the conservation of *V. novae-angliae* and other rare species of similar behavior may find themselves concerned at least as much with stewardship practices as with the ownership status of particular sites.

The majority of known *V. novae-angliae* populations are in private ownership (Table 2). Minnesota, where the species is most widespread, also has the highest percentage of sites in public ownership. While public ownership can increase a site's potential for conservation, public ownership in itself does not mean the site is adequately protected. Decisions about managing public land for the violet or other rare species must be site-specific and explicit. A vague objective like "resource conservation", however well-meant, is insufficient.

Little information is presently available regarding the current or proposed management of public tracts supporting extant *V. novae-angliae* populations. Consequently, our evaluation of the status of the species at the national, regional, and state levels is of necessity based primarily on the total number of verified sites and on known or crudely estimated population sizes compiled for individual states and provinces (Table 2). Generally, populations based on specimens collected on or after 1965 were presumed extant; however, the remote nature of the Boundary Waters region of Minnesota and Ontario, and the Manitoba collection, led us also to accept specimens collected in these areas as early as 1940 as presumably extant. In compiling an "order of magnitude" estimation of total plant numbers, we used actual counts or estimates provided by botanists wherever possible; for sites without such data, we arbitrarily but conservatively chose a population size of 20 for our estimation of total plant numbers. Plant numbers reflected only presumed extant sites in each state and province.

Unfortunately, data regarding population size were unavailable for the majority of confirmed populations. Actual counts or reliable estimates of numbers of individuals were incorporated into the estimates of statewide population numbers for Maine, Michigan, and New York, where information had been obtained for a substantial proportion of the confirmed extant populations. Thus, we consider estimates for these particular states to be good "ballpark" estimates. We believe that the state/provincial estimates over the remainder of the range of *V. novae-angliae* to be gross underestimates, at least for Minnesota, Ontario, and Wisconsin. Taking Minnesota as an example, and extrapolating from the estimate of 2,070 plants in 9 populations confirmed in 1988 field surveys by Ballard, we would arrive at a total estimate of 12,420 individuals for Minnesota. In that state, at least, and perhaps also in Ontario, the true number of individuals may approach or even exceed such an extrapolated estimate: field surveys demonstrated that *V. novae-angliae* occurred as virtually semi-continuous populations, occupying the suitable semi-continuous habitat that covers vast areas of the landscape in the Boundary Waters region.

In Wisconsin and elsewhere within the range of the violet, we suspect that the true total population size for a given state or province would lie somewhere between the conservative estimate provided by the "20-if-unknown" approach and the liberal estimate provided by the extrapolation approach. Such crude estimates of total numbers of individuals are perhaps useful at best as order of magnitude comparisons among states and provinces.

Given the large number (91) of recently verified populations and the wide distribution of these populations within the bimodal range of *V. novae-angliae*, we believe that the species is not threatened with extirpation across a significant portion of its range. We recommend dropping the species from the list of candidates for federal listing in the United States or Canada at this time—transferring *V. novae-angliae* from Category 2 to Category 3C. Many populations are in remote areas where the natural processes maintaining suitable conditions appear to continue largely uninterrupted, suggesting that the species is probably a persistent component of appropriate habitat over much of its range. Finally, we note that that many populations in the Great Lakes portion of its range are located on public lands which, if not now managed in a fashion suitable for the long-term maintenance of the violet, could be in the future.

Present data on the distribution and ecology of *V. novae-angliae* in certain states and provinces suggest that changes would be appropriate in the state-by-state listed status of the species (Table 2). In Minnesota, Ontario and Wisconsin the violet is well represented and potentially well protected, and is deemed to require listing no longer. Listing as "threatened" or "endangered" is recommended for Manitoba and Michigan until additional surveys document other populations of the violet there.

In Maine, the species has been verified in several locations, and a recent revision of the state's rare plant list dropped the violet from "threatened" to "special concern" status, which our data bear out as appropriate. Nearly all of the populations in the eastern region are thus far confined to Maine, although there is potential for new populations to be found in adjacent states and provinces. Populations in New York and New Brunswick number one and two, respectively, and the species would seem to warrant "endangered" status there.

The overall prospects for *V. novae-angliae*'s persistence throughout most of its range are good, provided representative habitats in both the Great Lakes and the greater New England portions of its range can be protected and, where necessary, managed. Unless its distribution or population status changes drastically, state-by-state and province-by-province protection (and management, where necessary) should be sufficient to assure the conservation of this species.

EPILOGUE

During the period 19–23 August 1993—after this manuscript was under review—the first author and Andrew Stuart of Madison, Wisconsin conducted a survey for state and federally listed plant and insect species along a proposed road alignment for the Voyageurs National Park in northern Minnesota (Ballard 1993). Over approximately three and one-half miles of alignment, in a 100-foot swath, they documented 15 populations of *Viola novae-angliae* ranging from one individual to over a thousand and estimated a total of 2150 plants in the surveyed area. During a visit to the park to reconnoiter populations and transplant individuals, additional searches of the proposed road alignment by William S. Alverson (1993) and park staff raised Ballard and Stuart's conservative estimate to over 5000 plants. The violet was found to be more widespread and more common locally than *V. sororia*. These additional populations would bring the number of confirmed extant populations and total number of localities across the range of *Viola novae-angliae* (Table 2) to 106 and 154, respectively.

On 30 September 1993, the United States Department of Interior published the removal of *V. novae-angliae* to category 3C in volume 58 of the "Federal Register".

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APPENDIX

The following specimens have been examined and verified as *Viola novae-angliae* House. Specimens representing the same apparent location are grouped together; locations are numbered consecutively.

CANADA. MANITOBA. [#1] Near West Hawk Lake, 7 Jun 1958, *Larsen s.n.* (WIS). NEW BRUNSWICK. [#2] Charlotte Co.: Lake Utopia, 8 Jul 1929, *Pease 20981* (GH); Lake Utopia, St. George, 6 Aug 1883, *Vroom s.n.* (NBM). [#3] Madawaska Co.: St. John River, Clair, 30 Jul 1969, *Christie 2360* (NBM). ONTARIO. [#4] Kenora District: Lac Seul, 3 mi east of Hudson's Bay Company post, 14 Jun 1941, *Baldwin 8756* (CAN); [#5] Commee Township, Highway 17 at Brule, 5 Jun 1965, *Allin 275* (CAN). Thunder Bay District: [#6] H. 11 at creek 9.5 mi. E. of Forestry Station, Blackwell Twp., Jun 1968, *Garton 10923* (CAN); [#7] Raith: 12 miles south at Oskondaga R., 27 May 1961, *Baldwin 8588* (CAN); [#8] Robbins Township, 20 Jun 1974, *Hartley 2040* (CAN); [#9] Elev. 1100 ft., Pearson Township, Hartwell Farm, Pearson Tp., 19 Jun 1973, *Hartley 1793* (CAN); [#10] Adjacent to air strip at Kakabeka Falls off Conc. II, Lot C, Oliver Twp., 1.3 km E. of Kakabeka Falls, 11 Jun 1979, *Garton 18674* (CAN, TRT); [#11] Vicinity of small creek on Burchell L. Rd. 1 km W of end on H. 802, 31 Aug 1981, *Garton 20597* (CAN, LKHD, MICH, TRT); [#12] at Curtain Falls, Sandy beach of Crooked Lake, 23 Aug 1952, *Lakela 15683* (DUL); [#13] Yum Yum Lake, Quetico Park, 28 Jun 1953, *Ahlgren 2439* (DUL); [#14] N. shore of Martin's Bay, 1 mi from head, Lac LaCroix, 16 Aug 1957, *Garton 5094* (DUL, LKHD, MT, TRT); [#15] above Bottle Lake at portage to Lac La Croix, 17 Aug 1957, *Garton 5107* (DUL, MT, TRT); [#16] on road E of Chapple's Farm, 6 mi SW of Fort William, Paipoonge Twp., 06 Jun

1966, *Allin 266* (LKHD); [#17] Trail to Fallingsnow Lake, 2 km N of lake, Devon Twp., 26 May 1980, *Garton 19377a* (CAN, LKHD, TRT); [#18] H. 593 at Arrow R. crossing on Lot 39, Devon Twp., 19 May 1986, *Garton 23246* (LKHD); [#19] Rt. bank of Weikwabinonaw Rd. at crossing of Great Lakes Forest Products Access Rd. to Buda L., 27 May 1981, *Garton 19945* (CAN, LKHD, MICH, TRT); [#20] Lyrster Township, Devon Road, (48°16′N, 89°52′W), 12 Jun 1965, *Allin 268* (CAN, LKHD). Rainy River District: [#21] Mine Centre, *Hosie 5274*, 8 Jun 1927 (TRT). USA. MAINE. Aroostook Co.: [#22] Shore of Allagash, 27 Jun 1961, *Bicknell* (MAINE); Allagash River, Twin Brooks Ledges, 1961, *Bean & Harris 22850*, (NEBC); [#23] Ft Kent, 23 Jul 1908, *Mackenzie 3666* (WIS); Fort Kent, St. John R., 12 Jul 1908, *Ware 1448* (MT); St. John R., Ft Kent, 25 Aug 1905, *Fernald s.n.* (GH); beach of the St. John R., below Fort Kent, 23 Jul 1908, *Churchill s.n.* (NEBC); St. John R., Ft. Kent, 26 Jul 1946, *Chamberlain & Ogden 4693* (MAINE); Ft Kent, valley of the St. John R., 15 Jun 1898, *Fernald 2245* (holotype of *V. novae-angliae* House, US); Brookline, My violet bed, Seeds from northern Maine, westerly one, May 26 and June 27 1908 [when collected from garden], *Forbes s.n.* (MIN); [#24] St. John R., St. Francis, 7 Jul 1904, *Shaw s.n.* (GH); St. John R., St. Francis, 7 Jul 1904, *Fernald & Collins s.n.* (GH, NEBC); St. John R., St. Francis, 18 Jun 1898, *Fernald 2244* (GH, NEBC); [#25] St. John R., T18 R10 WELS, Rocky Island, 9 Jun 1982, *Gawler 42* (MAINE); [#26] St. John R., Hunnewell Island, 9 Jun 1982, *Gawler 38* (MAINE); [#27] St. John R., Big Black Rapids T13 R15 WELS, 5 Jun 1982, *Gawler 36* (MAINE). Somerset Co.: [#28] Caratunk, 7 Jul 1925, *Norton 17990* (NHA). Penobscot: [#29] "Marsh Island", Orono, 7 Jun 1934, *Ogden 1182* (MAINE); [#30] Penobscot R., Veazie, 3 Jun 1906, *Knight 5024*, 19 Jul 1906, *5099* (GH, MIN, NEBC); by the Penobscot R., Veazie, 22 Aug 1908, *Fernald s.n.* (CAN, GH, MICH, MIN, MT, NEBC, TRT, WIS); Penobscot R., argillaceous ledges and shingle near the ferry, 26 Jun 1916, *Fernald 14134* (GH, NEBC); [#31] along the Penobscot, 10 Jul 1909, *Parlin 2961* (MAINE); [#32] Winn, argillaceous ledges by Penobscot R., 10 Jul 1916, *Fernald & Long 14136* (NEBC); [#33] Penobscot R., Milford, 1 Jul 1916, *Fernald s.n.* (NHA); [#34] Old Town, Stillwater R., Pushaw R., 26 Jul 1906, *Knight 5129* (GH); Stillwater, [no date], *Steinmetz s.n.* (MAINE); Stillwater, 14 Jun 1934, *Ogden* (MAINE); (Stillwater), Old Town, 08 Jul 1946, *Chamberlain & Ogden 4547* (MAINE). MICHIGAN. Crawford Co.: [#35] S of E/W unimproved road, 0.1 mi W of Howes Lake, SW1/4 of SE1/4, Sec. 32 of T27N, R04W, 21 May 1992, *Chittenden 421 & Peil* (MNFIP herb.); W side of Howes Lake, ctr S1/2, Sec. 32 of T27N, R4W, 20 Aug 1993, *Ballard 92-019* (WIS). Gogebic Co.: [#36] Ironwood, 10 Jun 1919, *Darlington s.n.* (MSC); [#37] Yondota Falls, site 66, SW1/4 of NE1/4, Sec. 33 of T47N, R43W, along SW side of Presque Isle R. just upstream of falls, 19 May 1991, *Foster 300* (WIS). Keweenaw Co.: [#38] Isle Royale, Duncan Bay, 18 Aug 1910, *Cooper 239* (GH). Schoolcraft Co.: [#39] [no specific locality], 27 May 1971, *Henson 53* (MICH); [#40] ca. 4 mi S of Creighton, 10 Jun 1986, *Henson 2024*, 16 Aug 1987, *Henson 2387A* (MICH); ca. 4 miles S of Creighton, 22 Jun 1987, *Reznicek 7940 & Henson* (MICH); [#41] near Driggs, 2 Jul 1934, *Fernald & Pease 3430* (holotype of *V. septentrionalis* var. *grisea* Fern., GH; isotype, MICH). MINNESOTA. Carlton Co.: [#42] at Thomson, in St. Louis R., 25 May 1940, *Lakela 3441* (DUL, MIN); ca 0.1 mi E of E village limit sign of Thomson, N shore of St. Louis River, 11 Aug 88, *Ballard 110* (MIN); [#43] Jay Cook Park, 23 May 1938, *Lakela 2383* (MIN); Jay Cook Park, below the Swinging Bridge, 27 May 1937, *Lakela 1918* (MIN); Jay Cook State Park, near swinging bridge, 23 May 1938, *Johnson 57* (DUL); Jay Cook Park, 06 Jun 1921, *Rosendahl 5247* (GH, MIN); Jay Cook Park, near suspension bridge, 01 Sep 1936, *Rosendahl & Butters 6720* (MIN); Jay Cook State Park, 1/4–1/2 mi E of park headquarters on terrace above rocky riverbank, 11 Aug 1988, *Ballard 88-103* (MIN); [#44] Approximately 6 mi SSE of Wrenshall, bordering the Soo Line Railroad track about 1 mi east of Highway 23, Sec. 22 of T47N, R16W, 13 Jun 1979, *Wheeler 3847* (MIN). Chisago Co.: [#45] Rusheba Twp., NW1/4, Sec. 18, 24 May 1941, *Moore & Thatcher 14094* (GH). Itasca Co.: [#46] Grand Rapids, 10 Jun 1970, *Phillips & Phillips s.n.* (MIN). Koochiching Co.: [#47] Growing in the vicinity of the Island View Hotel, Sec. 25 of T71, R22W, along the S shore of Rainy Lake, 12 Aug 1939, *Moore & Moore 11692*

(MIN); [#48] 9 miles north east of Big Falls, 20 May 1952, *Moore 21558* (MIN). Lake Co.: [#49] 4 mi portage between Fall and Basswood Lakes, 10 Jun 1950, *Ahlgren 646* (MIN, TRT); [#50] at the Forestry Cabin Lower Basswood River Falls, shore sand of Crooked Lake, 28 Aug 1956, *Lakela 20993* (DUL); [#51] at the Lower Basswood Falls, above the gorge, 28 Aug 1956, *Lakela 20992* (DUL); [#52] About halfway on Ely-Finland road, 27 Aug 1927, *Rosendahl & Butters 6882* (MIN); [#53] on Knife Island, 1/2 mi from the shore of Lake Superior, Knife R., 26 Jun 1942, *Lakela 4970* (DUL, MIN); [#54] near Knife R., North Shore, 19 Jul 1948, *Lakela 7646* (DUL); [#55] Sec. 35 of T63N R5W end of trail, 24 Jul 1957, *Lakela & Davidson 21530* (DUL, LKHD, MIN); [#56] in Baptism R. gorge, 16 Aug 1944, *Lakela 5683* (DUL), 10 Aug 1944, *Lakela 5682* (MIN); [#57] Finland State Forest Campground, Crystal Bay Twp., SE-1/4 of SW-1/4, Sec. 33 of T57N, R7W, 27 May 1988, *Ballard 88-016* (MIN); [#58] on Ely-Finland Rd 2.1 mi SE of Spruce Rd. and 3.7 mi SE of South Kawishiwi R., T61N, R11W, 27 May 1988, *Ballard 88-031* (MIN); [#59] South Kawishiwi R. State Forest Campground, Sec. 33 of T62N, R11W, on SE side of fee box circle near entrance, 27 May 1988, *Ballard 88-039* (MIN); [#60] 0.6 mi N of road going east to W shore of White Iron Lake, on E side of Hwy 1, SW1/4 of SW1/4, Sec. 11 of T62N, R12W, 27 May 1988, *Ballard 88-047* (MIN); [#61] immediately E of Co. Rd. 116-88 intersection, N of road, NE-1/4, Sec. 22 of T63N, R12W, 28 May 1988, *Ballard 88-050* (MIN); [#62] 1.3 mi N of Co. Rd. 116-88 intersection, T63N, R12W, 28 May 1988, *Ballard 88-064* (MIN); [#63] T61N, R15W, along Co. Rd. 135 0.8 mi N of Co. Rd. 26, 28 May 1988, *Ballard 88-086* (MIN); [#64] Embarrass Mtns., 0.1 mi N of LTV Steel Mining Co. entrance on Co. Rd. 135, T59N, R15W, 28 May 1988, *Ballard 88-091* (MIN); [#65] short distance SE of Ash Lake, W side of US-53 on rock outcrop, T66N, R20W, 12 Aug 1988, *Ballard 88-120* (MIN). Lake of the Woods Co: [#66] Near Norris Camp. Sec. 8 of T59N, R35W, 07 Jun 1979, *Boe 67* (MIN); [#67] at Hinckley, 22 May 1948, *Lakela 7420* (DUL). Roseau Co.: [#68] near Carp Trail, Sec. 24 R35W T61N, 16 Jun 1979, *Boe 204* (MIN). St. Louis Co.: [#69] Terrace of White Iron Lake at Burley's Resort, 24 Jun 1951, *Lakela 12601* (DUL, MIN); [#70] Near White Iron Lake, 12 Sep 1949, *Lakela 9753* (DUL); [#71] Echo Trail, near Fenske Lake N of Ely, 14 Jul 1949, *Lakela 8989* (DUL), 22 Jun 1954, *Lakela 17555* (DUL, MIN); Everett Lake, Echo Trail north of Ely, 14 Jul 1949, *Lakela 9005* (DUL); [#72] Palo, Anna Kilpela's farm, Brookside, 06 Jun 1938, *Lakela 2434* (MIN), 14 May 1939, *2854* (DUL, MIN), 11 Jun 1939, *2967* (MIN), 09 Jun 1940, *3471* (DUL, MIN); next to Anna Kilpela's Farm, Palo, along old RR track, 21 Jun 1938, *Lakela 2475* (DUL); Jack Lakela's farm, Palo, 09 Jun 1940, *Lakela 3479* (DUL); [#73] north of Island Lake Highway 73, 10 Jun 1956, *Lakela 20438* (DUL); [#74] Upper beach of Indian Lake, 03 Sep 1955, *Lakela 19472* (DUL, LKHD, MIN); [#75] 53, N of Virginia, 09 Jun 1953, *Lakela 16051a* (DUL); [#76] Lake Vermilion road near Vermilion R. dam, 08 Jun 1954, *Lakela 17351a* (DUL); [#77] Little Vermilion R., Minnesota-Ontario boundary, 28 Jun 1951, *Lakela 12774* (DUL, MIN); [#78] at Treasure Island Resort, Vermilion Lake, 08 Jun 1953, *Lakela 15984* (DUL, MIN); [#79] Ash R. Camp, Lake Kabetogama, 11 Jun 1950, *Lakela 10320* (DUL, MIN); [#80] N shore of Kabetogama Lake, opposite Pine Island, 14 Jul 1952, *Lakela 14970* (DUL); [#81] above Lost Bay, N shore of Kabetogama Lake, 16 Jul 1952, *Lakela 15094* (DUL, MIN); [#82] 26th Ave. W. Skyline Parkway, 08 Jun 1939, *Lakela 2919* (DUL, MIN); [#83] The new University Campus, meadow bordering Allen Avenue, Duluth, 18 Jun 1950, *Lakela 10448* (DUL, MIN); [#84] Gull Is., Namakan Lake, 5 mi from the Narrows, 19 Jun 1952, *Lakela 14311* (DUL); [#85] Rocky beach of Bottle Lake, Canadian border, 09 Aug 1953, *Lakela 16728* (DUL); [#86] above the falls, between Bottle Lake and Lac La Croix, Canadian boundary, in rock seams of Bottle R., 04 Jul 1954, *Lakela 17898* (DUL, MIN); [#87] about 1 mile S. of Idington, Hwy. 53, 01 Aug 1940, *Lakela 3849* (DUL, MIN, WIS); [#88] in Burntside Lake, Ely, shore rocks of an island, 24 Jun 1954, *Lakela 17671* (DUL); [#89] Highway 216, southwest of Hibbing, 24 Jun 1950, *Lakela 10523* (DUL, MIN); [#90] 16 miles N of Duluth, on shore rocks of Lake Superior, 07 Jun 1940, *Lakela 3466* (DUL, MIN); just N of Lester Park, Lake Sup. Duluth, 7 Jun 1940, *Lakela 3465* (DUL, MIN); [#91] Lake Superior. 14 mi N of Duluth, 15 Jul 1939, *Lakela 3164* (MIN); at Stony Point, North Shore rocks, 26 Jun 1955, *Lakela 18723a* (DUL);

[#92] Normanna T. N of Duluth, 29 May 1955, *Lakela 18628* (DUL); [#93] 13 mi N of Duluth, 27 May 1941, *Lakela 4341* (DUL); [#94] Sec. 1 of T58N, R13W, off Hwy 113, 4 Jun 1975, *Frye s.n.* (DUL); [#95] in Rainy Lake, near Finger Bay, high rocks of an island, 13 Jul 1951, *Lakela 13167* (DUL, MIN); [#96] in Rainy Lake, Cranberry Bay area, 10 Jul 1952, *Lakela 14849* (DUL, MIN); Rainy Lake, shore ledges of Cranberry Island, 17 Aug 1955, *Lakela 19288* (DUL); [#97] Fox Island, Rainy Lake, 17 Aug 1955, *Lakela 19310* (DUL), 8 Jul 1952, *Lakela 14554* (MIN); [#98] at Floodwood, Grassy bank of S[a]vanna River, 01 Jun 1957, *Lakela 21303* (DUL); [#99] at Skilo, 29 Jul 1947, *Lakela 7045* (DUL); [#100] Dry terrace of Floodwood Lake 73, 31 May 1952, *Lakela 14078* (DUL); [#101] Crooked Lake at Curtain Falls, resort grounds, 20 Aug 1950, *Lakela 11525* (DUL); [#102] between Iron and Crooked Lakes, 22 Aug 1950, *Lakela 11621* (DUL); [#103] Near Fond du Lac, 31 May 1937, *Borchard s.n.* (MIN); [#104] Meadowlands, 30 Jun 1912, [no collector] (MIN). NEW YORK. Warren County: [#105] along NE bank of Hudson River, 30 Jun 1981, *Sheviak 2033* (NYS). WISCONSIN. Barron Co.: [#106] Barrow [sic-Barron], *Cheney s.n.*, 10 Jun 1889 (WIS). Brown Co.: [#107] Suamico, Sec. 13 of T25N, R20E, Sensiba W. A., 22 May 1980, *Trick 80–159* (UWGB); [#108] Suamico, NW1/4, Sec. 24 of T25N, R20E, Sensiba Wildlife Area, 10 May 1987, *Vann s.n.* (UWGB); [#109] Suamico, NW1/4 of NW1/4, Sec. 36 of T25N, R20E, 4 May 1987, *Moore 604* (UWGB); [#110] Howard, Peter's Marsh, Sec. 1 of T24N, R20E, 15 May 1981, *Fewless 81–69* (UWGB); Howard, Sec. 1 of T24N, R20E, behind Peters marsh, 22 May 1980, *Trick 80–160* (UWGB). Chippewa Co.: [#111] Sec. 26 of T31N, R9W, 30 Apr 1988, *Morris s.n.* (UWSP). [#112] Douglas Co.: Amnicon Falls State Park, along the river rapids, 15 Aug 1988, *Ballard 88–154* (WIS); [#113] NE1/4 of SE1/4, Sec. 14 of T46N, R12W, east side of old Hwy. 53, 19 May 1992, *Judziwiecz s.n.* (WIS); [#114] S of 22 St & Weeks Ave, Superior, 12 Jun 1942, *Thomson 5032* (WIS); [#115] Clough Ave. & 23 St, Superior, 9 Jun 1943, *Thomson 5430* (WIS); Superior, Jun 1927, *Shaw 517* (WIS). Forest Co.: [#116] Waubikon Lake, 28 May 1929, *Keefe 16* (WIS). Iowa Co.: [#117] SE1/4 of SW1/4, Sec. 30 of T8N, R5E, North Svenson Prairie, 1 May 1993, *Cochrane 12899, Williams, Baskin, Baskin & Ulrich* (WIS). Iron Co.: [#118] Mercer, Jun 1909, *Ogden s.n.* (GH, MIN). Lincoln Co.: [#119] extreme NE corner, Sec. 19 of T31N, R7E, along Wisconsin River, 26 May 1981, *Alverson 1757 & 1756* (WIS); tn Pine River, along Wisconsin River, Sec. 19 of T31N, R7E, 20 Jul 1974, *Seymour 15920* (WIS); [#120] Sec. 28 of T31N, R7E, at Pine River Dells, 17 May 1981, *Alverson 1761* (WIS); Sec. 28 of T21N, R7E, Tn Pine River, Pine River Dells, 18 Aug 1952, *Seymour & Schlising 14696* (WIS); Pine River Dells, Sec. 28 of T31N, R7E, SE side of Pine River, 25 May 1988, 16 Aug 1988, *Ballard 88–012* (WIS). Marathon Co.: [#121] Sec. 12 of T27N, R7E, 29 May 1967, *Sternberg 7* (WIS). Marinette Co.: [#122] Dunbar, Sec. 3 of T37N, R18E, 29 May 1988, *Fewless 4284* (UWGB), 17 Jul 1988, *Fewless 4528* (UWGB). Oconto Co.: [#123] Oconto, Sec. 31 of T28N, R22E, Drosera site, 28 May 1980, *Trick 80–180* (UWGB). Portage Co.: [#124] SE1/4, Sec. 24 of T22N, R8E, 12 Jun 1956, *Iltis & Russell 5666* (WIS); Sec. 24 of T22N, R8E, 27 May 1956, *Iltis 5677* (WIS); [#125] Sec. 20 of T24N, R8E, 15 May 1970, *Lemke s.n.* (UWSP); [#126] Grant Tp, center of N edge, Sec. 18 of T22N, R7E 6 Jun 1974, *Freckmann 10383, 10382* (UWSP); [#127] Grant Tp, Sec. 26 of T21N, R7E, 4 May 1974, *Schmutz 13* (UWSP); [#128] Sec. 17 of T24N, R8E, 6 May 1981, *Barth s.n.* (UWSP); [#129] Sec. 10 of T22N, R7E, 29 May 1984, *Freckmann & Freckmann 19389* (UWSP). Rusk Co.: [#130] NE1/4 SE1/4, Sec. 33 of R6W, T33N, 2 Jun 1973, *Olesiak 94* (UWSP). Sheboygan Co.: [#131] Evergreen Pk, 20 Jun 1923, *Goessl s.n.* (WIS); [#132] Sheboygan, 28 May [no year], *Goessl s.n.* (WIS); Sheboygan, 21 May 1920, *Goessl s.n.* (WIS). Walworth Co.: [#133] Whitewater, 19 May 1882, *Sykes s.n.* (WIS). Winnebago Co.: [#134 Menasha, 18 May 1859, [no collector] (WIS); [#135] Alpine Rd, Sec. 8 of T20N, R14E, 2 Jun 1973, *Rill 3979* (OSH). Wood Co.: [#136] Sec. 12 of T22N, R5E, 24 May 1976, *Bogdansky s.n.* (UWSP); [#137] Remington Tp, SW1/4, Sec. 1 of T21N, R2E, at bottom of section 1, 23 May 1974, *Reynolds s.n.* (UWSP).

NEW DISTRIBUTIONAL RECORDS IN RELATION TO THE PHYTOGEOGRAPHY AND FLORISTIC DIVERSITY OF THE EASTERN LAKE ONTARIO REGION

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ABSTRACT

Andropogon virginicus, *Carex gracilescens*, *C. swanii*, *Corallorhiza odontorhiza*, *Cyperus erythrorhizos*, *Celtis tenuifolia* and *Leptoloma cognatum* are added to the list of southern species, mostly of the eastern deciduous forest zone, that occur in the eastern Lake Ontario region. *Aster acuminatus* and *Carex appalachica* are additions to the eastern flora of this interesting but poorly known region. The presence of southern and eastern elements is attributed to a combination of climatic factors and a migration route around the eastern end of Lake Ontario. Recent additions to the western prairie flora of this region include *Carex bicknellii*, *Dichanthelium leibergii*, *D. villosissimum* var. *praecocius*, *D. perlongum*, *Sporobolus asper*, *Ranunculus rhomboideus*, and *Vicia americana*. The presence of western elements is attributed to a combination of dry, open habitats more or less connected with similar habitats to the west, and introduction by indigenous people. The eastern Lake Ontario region is important with regard to zonal boundaries, floristic transition, and high floristic diversity.

The region at the eastern end of Lake Ontario is well known as an area of occurrence of many southern species. Fox and Soper (1954) showed combined distributions of 11 species of trees and shrubs found in the Carolinian zone of Ontario, but with disjunct occurrences in the eastern Lake Ontario region from Northumberland County east to the Thousand Islands. Later, Thaler and Plowright (1973) also found this secondary outlier of the Carolinian zone using a different methodology. A good example of a plant demonstrating this pattern is *Lindera benzoin* (L.) Blume, which is found in Ontario in the traditional Carolinian zone north of Lake Erie and along the southern Lake Huron shore, with disjunct occurrences in the Georgian Bay region and in the eastern region of Lake Ontario (Soper & Heimburger 1982). Other examples, lacking occurrence in the Georgian Bay region, are *Anemonella thalictroides* (L.) Spach (Cody 1982), *Jeffersonia diphylla* (L.) Pers. (Soper 1962), and *Vaccinium stamineum* L. (Cody 1982, Haber & Keddy 1984).

Outside of Ontario, the deciduous forest region is probably a better known and more well defined floristic zone than the Carolinian zone. The deciduous forest region includes much of the characteristic vegetation that occurs to the south of eastern Canada (e.g. Weatherbee & Crow 1990). The traditional Carolinian zone limit established by Fox and Soper (1954) has been considered approximately identical to the northern limit of the deciduous forest region by some botanists (e.g. Scoggan 1965), while others have extended the deciduous forest region (as the "Niagara section") northeastward into the eastern Ontario region (e.g. Rowe 1972), thus supporting additional evidence of the occurrence of southern elements in this region.

The eastern Lake Ontario region is less well known as a region where western elements occur (Catling & Catling 1994). Western species near to their eastern limits include the prairie grasses *Bouteloua curtipendula* (Michx.) Torr. (Reznicek 1984a) and *Sporobolus heterolepis* A. Gray (Reznicek 1984g) and herbs such as Prairie Smoke, *Geum triflorum* Pursh, the latter reaching its absolute eastern limit on the nearby Chaumont Barren near Watertown, New York.

In addition to the western and southern elements, a few species with largely eastern distributions, such as *Viburnum alnifolium* Marshall and *Acer pensylvanicum* L., have previously been reported from the eastern Lake Ontario region (Soper & Heimburger 1982) and recently documented at additional sites in the region (Brownell 1993).

The potential significance of the eastern Lake Ontario region with respect to zonal boundaries is thus evident, but with the notable exception of Presqu'ile Provincial Park and the Kingston area, it is a region that has received little botanical attention (e.g. Argus 1992). Here we report some range extensions of phytogeographic interest for various eastern, southern (deciduous forest zone), and western species recently discovered in this region. These discoveries are evaluated as further support for the importance of the area as a transition zone and a region of high floristic diversity.

Herbarium abbreviations follow Holmgren et al. 1990.

EASTERN SPECIES

Aster acuminatus Michx.

Whorled Wood Aster is frequent in acid swampy woods of eastern Ontario but becomes rare westward to the Georgian Bay area. It has a distinctive eastern distribution (Fig. 1). At Spencer Point it occurred at the base of a drumlin adjacent to a black ash-white cedar swamp.

NORTHUMBERLAND CO.: Cramahe Twp.: Spencer Point Swamp, 6 km SW of Brighton, 44°00′48″ N, 77°48′30″ W, 18 Aug 1992, *V.R. Catling [Brownell] s.n.* (DAO)

Carex appalachica Webber & Ball
(*Carex radiata sensu* Mackenzie)

This species, rare in Ontario and previously known only from western Lake Ontario, the north shore of Lake Erie and the Niagara area, has an Appalachian distribution (Ball & White 1982c, Webber & Ball 1984). In a ravine between Port Granby and Wesleyville, Ontario, it occurred on dry slopes in a sugar maple-red oak-white birch forest.

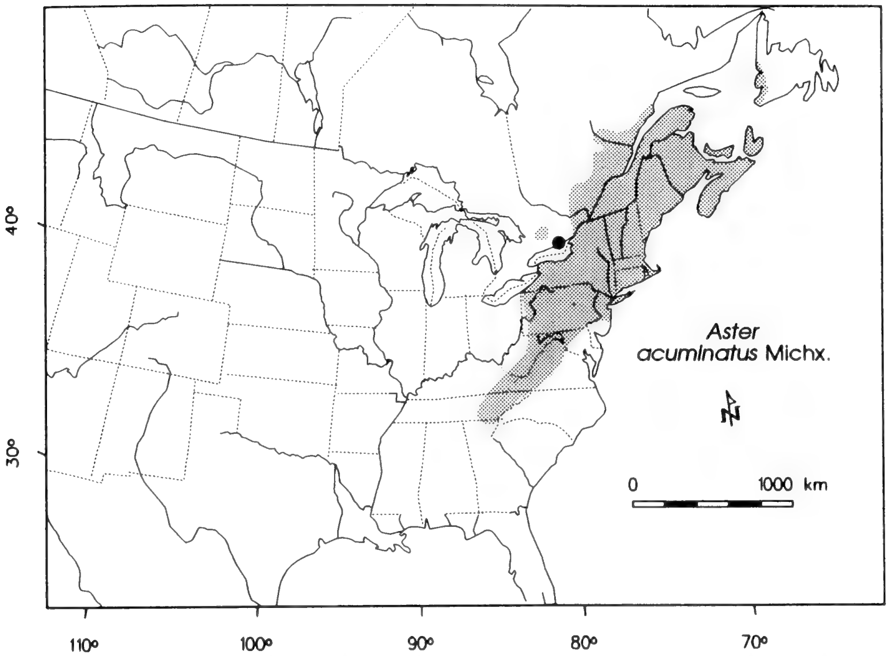

FIGURE 1. North American distribution of *Aster acuminatus* after Semple & Heard (1987) and Brouillet & Simon (1981), but with the Norfolk Co., Ontario record deleted due to lack of support in recent floristic inventories. The dot covers the eastern Lake Ontario occurrence.

NORTHUMBERLAND CO.: Hope Twp.: Port Granby East Ravine, 43°54′56″ N, 78°26′15″ W, 4 Aug 1992, *V. R. Catling [Brownell] s.n.* (DAO).

SOUTHERN SPECIES

Andropogon virginicus L.

This southern grass was first noticed in southwestern Ontario in 1976 (Catling et al. 1978), having been previously confused with *Schizachyrium scoparium*. Until the recent discoveries in Northumberland County, it had been found only in the Carolinian region of southwestern Ontario.

NORTHUMBERLAND CO.: Brighton Twp.: Goodrich-Loomis Conservation Area, 11.6 km NW of Brighton, 44°07′30″ N, 77°49′25″ W, 2 May 1994, *P.M. Catling s.n.* (DAO); 20 Aug 1994, *V.R. Brownell s.n.* (DAO). Murray Twp.: Murray Hills Significant Natural Area, 3.3 km NW of Trenton, north side of Hwy 401, 44°07′17″ N, 77°38′00″ W, 9 Oct 1994, *S. Blaney s.n.* (DAO).

Carex gracilescens Steud.

This species was previously known in Ontario only from the Carolinian zone, and is considered rare in the province (Ball & White 1982b). It is rare and local in woods along the Salmon River where other Carolinian species, such as *Carex oligocarpa* Schk., *Erythronium albidum* Nutt., and *Jeffersonia diphylla* approach their northern limit. It is locally common in periodically moist bur oak (*Quercus macrocarpa* Michx.) woods near Lonsdale and in Prince Edward Co. south of Deseronto.

HASTINGS CO.: Tyendinaga Twp.: E side of Salmon River south of Hwy. 401, Map 31 C/3, UTM 261992, 12 June 1987, *Oldham 7328* (DAO, MICH, TRTE). 2 km SSW of Lonsdale, 44°15′30″ N, 77°07′45″ W, 13 June 1994, *P. M. Catling, Oldham & T. Norris 20288* (DAO). **PRINCE EDWARD CO.**: Sophiasburgh Twp.: 4.7 km SW of Deseronto, 44°09′22″ N, 77°05′00″ W, 13 June 1994, *Oldham 16168 & P.M. Catling* (DAO).

Carex swanii (Fern.) Mackenzie

This species has been reported from scattered locations in southwestern Ontario, ranging from Essex to Niagara County (Ball & White 1982d). Its occurrence in the Eastern Townships of Québec (Bouchard et al. 1983), however, suggests that it may have been overlooked in southeastern Ontario. The new station southwest of Trenton occurred at the edge of an intermediate-aged woods dominated by black cherry. Approximately 50 plants were found.

NORTHUMBERLAND CO.: Brighton Twp.: Swing Bridge Woods ESA, approx. 6 km E of Brighton near the Murray Canal, 44°02′28″N, 77°40′00″W, 3 Aug 1992, *Brownell s.n.* (DAO).

Celtis tenuifolia Nutt.

A rare plant in Ontario (Keddy 1984) and Canada (Argus and Pryer 1990), dwarf hackberry was previously known only from Pelee Island, Point Pelee and the dunes near Grand Bend. The four sites in the eastern Lake Ontario area extend its known range approximately 350 km to the ENE and represent a disjunct northeastern range limit (Fig. 2). The sites in the southern Great Lakes region, including southwestern Ontario, southern Michigan, and northern Ohio, also represent a disjunction from the main range of this species further to the south (Fig. 2, Keddy 1984, Wagner 1974). Boivin (1967) considered plants from the northern part of the range to be distinct and named them var. *soperi*, but this name appears not to have been taken up. *Celtis tenuifolia* is considered a species of "special concern" in the adjacent state of Michigan (Beaman et al. 1983) and is listed as "potentially threatened" in Ohio (Ohio Department of Natural Resources 1988). At Point Anne it occurs on shallow soil over limestone rock with the essentially southern *Quercus muehlenbergii* Engelm., two prairie grasses (*Sporobolus heterolepis* and *Andropogon gerardii* Vitman), the regionally rare *Arabis holboellii* Hornem., and several characteristic alvar species. At

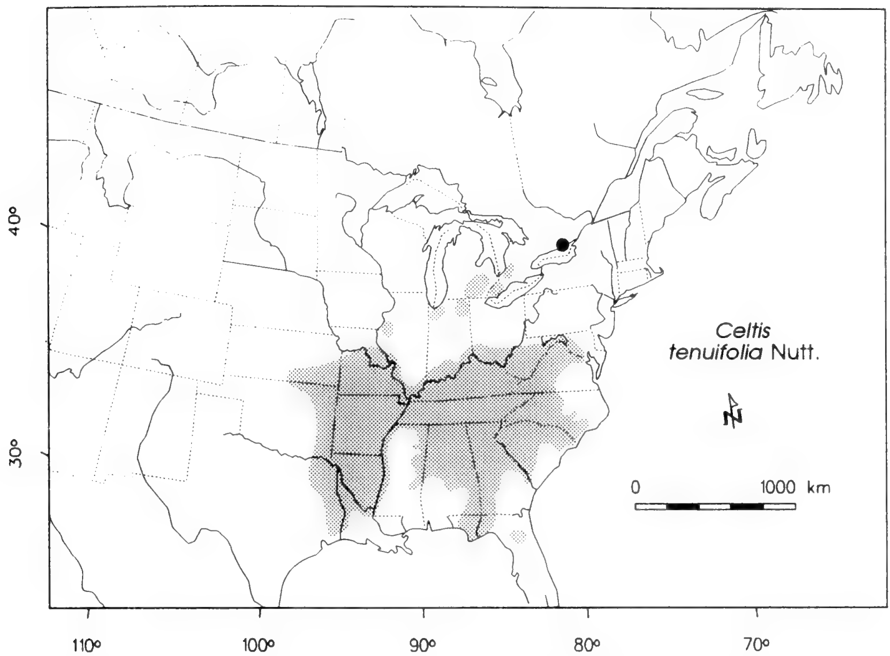

FIGURE 2. North American distribution of *Celtis tenuifolia* after Little (1977) and Wagner (1974). The dot covers the eastern Lake Ontario occurrences.

the sites along the Trent River in Sidney Township, it occurs on open, sandy, calcareous, west-facing slopes also in a prairie habitat with species such as *Amelanchier alnifolia* Nutt., *Andropogon gerardii*, *Aster oolentangiensis* Riddell, *Ceanothus herbaceus* Raf., *Schizachyrium scoparium* (Michx.) Nash., and *Stipa spartea* Trin. Near Lonsdale, where initially discovered by Mr. T. Norris of the Ontario Ministry of Natural Resources, *Celtis tenuifolia* occurs in cracks in limestone pavement where it is associated with *Juniperus communis* L. as well as a variety of trees of dry and mesic sites. The mesic species are able to persist on the high pavement in deep and sometimes wide cracks. At Lonsdale, a notable associate is the provincially rare *Euphorbia commutata* Engelm.

HASTINGS CO.: Sidney Twp.: Ketcheson's Prairie Opening, 44°13′40″ N, 77°35′11″ W, 16 Aug 1991, *Catling & Catling 9924* (DAO); Game Club Prairie Openings, 44°13′20″ N, 77°35′05″ W, 16 Aug 1991, *Catling & Catling 9920* (DAO); New Overlook Prairie Opening, 44°14′00″ N, 77°35′10″ W, 22 Aug 1991, *Catling, Catling & McKay-Kuja 9906* (DAO). Thurlow Twp.: Point Anne, Topo. Map 31 C/3, UTM 159926, 5 Sept 1987, *Oldham et al. 7864* (MICH); Point Anne, approx. 5 km E of Belleville, 44°09′10″ N, 77°17′55″ W, 9 July 1991, *P. M. Catling s.n.* (DAO). Tyendinaga Twp.: 2 km SSW of Lonsdale, 44°15′30″ N, 77°07′45″ W, 13 June 1994, *P. M. Catling 20281, Oldham & T. Norris* (DAO).

Corallorhiza odontorhiza (Willd.) Nutt.

Twenty-eight plants of the Fall Coral-root were discovered in a mature white pine-sugar maple forest near Trenton. All plants seen had cleistogamous flowers and some were in peak flowering at the time of collection. They were growing near a trail that had been more open approximately 20 years earlier as suggested by remnant bushes of *Juniperus communis* and *Vaccinium angustifolium*. The dominant herbaceous species were *Carex pensylvanica* and *Pteridium aquilinum*. Previously this species was known in Ontario only from the Carolinian zone and Lake Huron shore.

NORTHUMBERLAND CO.: Murray Twp.: Murray Hills, 3.3 km NW of Trenton, 44°06′50″ N. 77°38′37″ W, 12, 19 Oct 1994, *V.R. Brownell, S. Blaney, P. M. Catling, s.n.* (DAO).

Cyperus erythrorhizos Muhl.

Previously known only from the traditional Carolinian zone, this species is considered rare in Ontario (Ball & White 1982e). In Presqu'ile Provincial Park it is apparently rare and local on sandy beaches.

NORTHUMBERLAND CO.: Brighton Twp.: Presqu'ile Provincial Park, Map 30 N/13, UTM 810742, 3 Sept 1985, *M.J. Oldham, R.D. McRae & M. Delisle-Oldham 5542* (DAO, MICH).

Leptoloma cognatum (Schultes) Chase

Aptly named Fall Witch Grass, this rare southern species was just starting to emerge from its sheaths in early October at the new site near Brighton. Reznicek (1984e) indicates only two native occurrences in Ontario in Kent County and near Windsor, Essex County. Five other populations in southwestern Ontario are considered adventive owing to their close proximity to railways. This represents the most eastern site for this species in Canada. The Brighton plants were found in a small opening on a partially forested drumlin adjacent to a large wetland. The soils are very sandy and support various native species of dry openings such as *Danthonia spicata* (L.) P. Beauv., *Cyperus lupulinus* (Sprengel) Marcks., *Equisetum hyemale* L., *Desmodium canadense* (L.) DC, *Potentilla canadensis* L., and *Spiranthes casei* Catling & Cruise.

NORTHUMBERLAND CO.: Cramahe Twp.: Spencer Point Creek ESA, approx. 6 km SW of Brighton, 44°00′48″N, 77°48′25″W, Map 31 C/4, UTM 747766, 3 Oct 1992, *Brownell s.n.* (DAO, MICH).

WESTERN SPECIES

Carex bicknellii Britton

This species is apparently widespread in the tall grass prairie region extending narrowly eastward to New England and New Jersey (Ball & White 1982a). In Ontario it was previously known only from the southwestern Ontario tall grass prairies at Windsor and Walpole Island (Ball & White 1982a), and from prairie relicts near Brantford and Ancaster in southwestern Ontario. At the Deseronto site it occurs with *Andropogon gerardii* and *Sporobolus heterolepis* on an open slope in bur oak woods and nearby in shallow soil over limestone with *Poa compressa* L. The site may be a relict of a once extensive opening at what was known as "Mohawk Landing" in settlement times (see also under *Dichanthelium leibergii*).

HASTINGS CO.: Tyendinaga Twp., approx. 3 km WSW of Deseronto, 44°11′10″ N, 77°05′15″W, 11 June 1994, *P.M. Catling & Oldham 20324* (DAO).

Dichanthelium leibergii (Vasey) Freckmann var. *leibergii* (*Panicum leibergii* (Vasey) Scrib. var. *leibergii*)

Previously this mostly western species was known in southern Ontario only from prairies on Walpole and Squirrel Islands in Lambton County (Reznicek 1984b, Fig. 3). At the newly discovered station west of Deseronto it occurs on the edge of a graveyard at the old Mohawk settlement of Mohawk Landing. This excellent campsite on a major travel route was undoubtedly occupied by Indians prior to the war of 1812, to which its settlement is dated on historic plaques. The natural dry openings near Deseronto were mostly alvars rather than prairies, the prairie vegetation being primarily associated with Indian settlements. The prairie elements at this site may have been brought by Indians and the open habitat maintained by Indians, but regardless of the possible involvement of indigenous people, the prairie vegetation very likely predated settlement by Europeans.

The cemetery is on a wooded knoll with large white pine, bur oak, red oak, shagbark hickory and some red cedar. On the south and west edges there are open areas dominated by prairie grasses, mostly *Andropogon gerardii* and *Sorghastrum nutans* (L.) Nash. Other noteworthy species present here include *Aster oolentangiensis*, *Bouteloua curtipendula*, *Carex siccata* Dewey, *Ceanothus americanus*, *Cerastium arvense* L., *Corylus americana* Walter., *Eleocharis compressa* Sullivant., *Erigeron pulchellus* Michx., *Galium boreale* L., *Geum triflorum*, *Helianthus divaricatus* L., *Potentilla arguta* Pursh., *Schizachyrium scoparium*, and *Verbena simplex* Lehm.

HASTINGS CO.: Tyendinaga Twp.: south and west sides of Mohawk Pentecostal Cemetery, 2.5 km SW of Deseronto at 44°10′59″ N, 77°04′56″ W, 23 Aug 1992, *Catling & Catling 13500* (DAO), 11 June 1994, *P.M. Catling & Oldham 20325* (DAO).

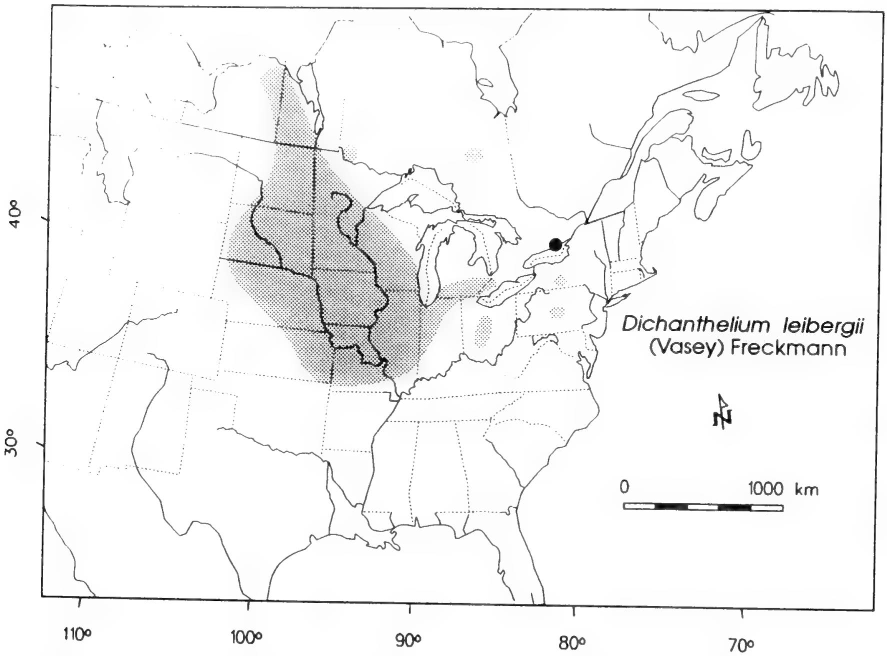

FIGURE 3. North American distribution of *Dichanthelium leibergii* after Reznicek (1984b). The dot covers the eastern Lake Ontario occurrence.

Dichanthelium villosissimum (Nash) Freckmann var. *praecocius* (Hitchc. & Chase) Freckmann
(*Panicum praecocius* Hitchc. & Chase)

This largely western taxon is rare in Ontario (Reznicek 1984d) and was previously unknown east of the Regional Municipality of York and the Niagara River where it reached its northeastern limit. Its range is here extended eastward to the Rice Lake Plains area (Catling et al. 1992) and the valley of the lower Trent River. This species was lumped under *Panicum acuminatum* Scribner by Morton and Venn (1990).

HASTINGS CO.: Sidney Twp.: near Stirling, 44°16′00″ N, 77°32′20″ W, 16 Aug 1991, *Catling & Catling 9901* (DAO); Game Club Prairie Openings, 44°13′20″ N, 77°35′05″ W, 16 Aug 1991, *Catling & Catling 9917* (DAO). **NORTHUMBERLAND CO.**: Brighton Twp.: W side of Goodrich-Loomis (Cold Creek) Conservation Area, 11.6 km NW of Brighton, 44°07′00″ N, 77°49′50″ W, 10 June 1994, *S. Blaney 136* (DAO). Cramahe Twp.: Salt Creek Prairie, *ca.* 6.5 km N of Castleton, 44°08′30″ N, 77°57′30″ W, 10 July 1990, *Catling & Catling 8206* (DAO). Haldimand Twp.: Harwood Slope Prairie, 3.5 km E of Harwood, 44°08′00″ N, 78°08′20″ W, 5 July 1990, *Catling & Catling 8210* (DAO); Oak Heights Prairie, 6.5 km NNW of Castleton, 44°07′40″ N, 77°58′25″ W, 5 July 1990, *Catling & Catling 8237* (DAO). Harwood Lupine Prairie, 3 km E of Harwood, 48°08′00″ N, 78°08′00″ W, 7 July 1990, *Catling & Catling 8268* (DAO). Hamilton Twp.: Sully Slopes, 44°06′50″ N, 78°12′25″ W, 5 July 1990, *Catling & Catling 8178*

(DAO); Valley Farm area, 44°06′40″ N, 78°10′25″ W, 5 July 1990, *Catling & Catling 8175* (DAO).

Dichanthelium perlongum (Nash) Freckmann
(*Panicum perlongum* Nash)

A rare species in Ontario, this western plant was known in the province from only two old collections (Reznicek 1984c) until recently when an additional station was discovered in southwestern Ontario and its known range was extended east of the Regional Municipality of Durham (Pontypool area) to the Rice Lake Plains area (Catling et al. 1992) and valley of the lower Trent River. This species was lumped under *Panicum linearifolium* Scribner by Morton and Venn (1990).

HASTINGS CO.: Sidney Twp.: near Stirling, 44°16′00″ N, 77°32′20″ W, 16 August 1991, *Catling & Catling 9903* (DAO). **NORTHUMBERLAND CO.**: Alnwick Twp.: Hog's Back Prairie, 2 km SW of Alderville, 44°10′20″ N, 78°05′00″ W, 7 July 1990, *Catling & Catling 8173* (DAO, MICH). Cramahe Twp.: Red Cloud Cemetery, *ca.* 6 km N of Castleton, 44°08′30″ N, 77°56′37″ W, 10 July 1990, *Catling & Catling 8205* (DAO). Haldimand Twp.: Oak Heights Pit, 2.5 km SSE of Burnley, 44°08′27″ N, 78°00′45″ W, 9 July 1990, *Catling & Catling 8195, 8200* (DAO); Oak Heights Prairie, 6.5 km NNW of Castleton, 44°07′40″ N, 77°59′25″ W, 5 July 1990, *Catling & Catling 8231* (DAO).

Sporobolus asper (Michx.) Kunth var. *asper*

This primarily western grass has recently spread east along railways and roadsides. It is rare in Ontario (Reznicek 1984f), and there are only 8 occurrences that probably predate settlement by Europeans. A ninth was recently discovered along the banks of the river below the well established Indian site at Healey Falls. *Sporobolus asper* was frequent in several patches with *Andropogon gerardii* and *Carex eburnea* F. Boott. on the west shore opposite Cole Point, but a few plants also occurred along the east shore.

It is of interest that this is also the place where *Bouteloua curtipendula* was collected in 1862. This rare western grass was rediscovered in 1989 (DAO) in an opening among bur oaks on shallow soil over limestone rock at the top of a cliff on what was once an island in the centre of the falls. Here it dominated the vegetation over approximately 20 square metres, occurring with *Ranunculus fascicularis* Muhl. Healey Falls is also one of the few places in Ontario where the White Prairie Gentian (*Gentiana flavida* A. Gray) has been found.

NORTHUMBERLAND CO.: Seymour Twp.: Healey Falls area, along rivershore opposite Cole Point, 44°23′00″ N, 77°47′00″ W, 16 Aug 1991, *P. M. Catling & V. R. Catling 9940* (DAO).

Ranunculus rhomboideus Goldie

Another western species, prairie buttercup was long known from central Ontario and described from the old Indian site of Holland Landing at the south end of Lake Simcoe (Reznicek 1980). Its occurrence in the Pontypool–Rice Lake area was mapped by Williams (1984), who included also a map of its overall distribution in the province. Williams (1985) later extended its range west to Cramahe Township of Northumberland County, this being its eastern range limit. In this area of the once extensive Rice Lake Plains (Catling et al. 1992), it survives in old fields and prairie remnants. Like some of the other western elements noted here, its absolute eastern limit appears to be the recently discovered prairie site along the lower Trent River. Here it occurred with *Carex siccata*, *Carex pensylvanica* Lam., *Stipa spartea*, and *Schizachyrium scoparium* on open slopes. It was reported from Montreal by Macoun (1883) and by Fernald (1950), but this report is suspect (Scoggan 1978) and was not repeated by Bouchard et al. (1983).

HASTINGS CO.: Sidney Twp.: Game Club Prairie Openings, 44°13′20″ N, 77°35′05″ W, 3 June 1991, *Catling & Catling 9039* (DAO).

Vicia americana Muhl. var. *americana*

This widespread species has most of its range in western North America, where two other varieties occur. It is known from the Carolinian region of southwestern Ontario and from lake shores and river shores of northern Ontario and adjacent Québec (Fort Temiscamingue, DAO), but has not previously been found in eastern Ontario, which is on the northeastern edge of its range. At the Deseronto site it was associated with *Carex sartwellii* in periodically dry *Quercus macrocarpa* woodland, near to drier sites with *Carex bicknellii* Britton and *Sporobolus heterolepis*. Its nearness to the Indian site where *Dichanthelium leibergii* (see also under latter species) was found suggests possible introduction by Indians.

HASTINGS CO.: Tyendinaga Twp., approx. 3 km WSW of Deseronto, 44°11′10″ N, 77°05′15″W, 11 June 1994, *P.M. Catling & Oldham 20323* (DAO).

CONCLUSIONS

The eastern Lake Ontario region is an area of relatively high floristic diversity. This diversity may be accounted for in part by the fact that it is a region of phytogeographic zonal boundaries, a region where species from the east, west, and south reach their limits. While this fact contributes to an understanding of the regional diversity, there is still a question why this should be a boundary region. The reasons appear to involve at least a combination of climatic and habitat factors.

Almost all of the largely western elements in this region are plants of periodically dry, open habitats, and their presence may be a consequence of extensive open habitats which existed in the region prior to settlement, and were more or less connected to more extensive open areas to the south and west (Catling et al. 1992, Catling & Catling 1994), as well as possible introduction by Indians and persistance around Indian sites (Reznicek 1983). The Bay of Quinte and Trent River were major Indian trade routes and included numerous Indian settlements. Extensive open areas were created around such settlements, the wood having been burned or utilized for heating, shelter, cooking, etc. (Day 1953).

Eastern species of the maritime provinces and northern Appalachian Mountains exist in a climate that is generally milder and wetter than that of much of southern Ontario. Parts of the eastern Lake Ontario region have a lower summer temperature range than surrounding regions and are somewhat cooler in spring (Brown et al. 1980). The short distances between islands in the St. Lawrence River may have facilitated the spread of eastern species into Ontario from the nearby cool and moist region at the eastern end of Lake Ontario where they are well represented.

The presence of southern species in the eastern Lake Ontario region may be due to some extent to climatic similarities with areas to the south. For example, the region has summer temperatures similar to those of much of the traditional Carolinian zone of extreme southern Ontario (Brown et al. 1980). The mean date of first frost is also equivalent to that in parts of the Carolinian zone. As with the eastern floristic elements, a migration route around the eastern end of Lake Ontario may also be a contributing factor.

The traditional "Carolinian zone" of Ontario, with a boundary nearly equivalent to that established by Fox and Soper (1954) has been accepted as a focus for conservation efforts in the province and the nation (e.g. Allen et al. 1990). While there is ample justification for this, it is noteworthy that the eastern Lake Ontario outlier of this zone has received relatively little attention, despite the fact that it is a boundary and transition region, and, like the traditional Carolinian zone of Ontario, has a high floristic diversity as well as a concentration of rare species (Argus 1992) and rare communities.

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PROMINENT MICHIGAN BOTANISTS
I. Clarence Robert Hanes (1874–1956)

By Emma Bickham Pitcher
1400 N. Drake Rd., #169
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"The depression had come and our losses were rather serious. Bank stock was gone and an assessment had been paid. Detroit real estate bonds were almost worthless. Stock for which we had paid $53.00 per share was quoted at less than $8.00. We decided that it would be far better to take up a work that would be valuable to us in keeping our minds occupied and might also add something of value to the knowledge of our county and state."

—Clarence Hanes, 1933

So begins the saga of the botanical efforts of Clarence and Florence Hanes. The plant census embarked upon resulted in the 1947 publication of the 272-page volume entitled *Flora of Kalamazoo County, Michigan*.

Clarence Robert Hanes was born in 1874 in a modest frame farmhouse in Schoolcraft, Kalamazoo County, a home acquired by his parents in 1862, and Clarence's home for his entire life. In 1891, while in high school, Clarence made a herbarium collection of some 80 species of Schoolcraft Township trees and plants, but when he went to the University of Michigan his major subjects were language, history and economics. In 1898 Clarence took his B.A. degree back to his parents' home and became a high school biology teacher, a post he held for some years.

In 1905 Clarence studied and collected 22 ferns and 24 orchids in the Sugarloaf Lakes area north of his home. This small area became one of his favorite study sites, the locale of many field trips. Among the rare finds are the following plants, with Clarence's notes about each species written in the *Flora*:

Lycopodium tristachyum Pursh. Ground Cedar. Rare. Near Sugarloaf Lake there is one section on Fox Island, two to the northeast of the Lake; . . . With us it has always been associated with black or white oak. We have never found it in fruit.

Epigaea repens. Trailing Arbutus. Rare. Arbutus is found sparingly in Kalamazoo County, growing always in white or black oak woods, never far from swamps.

Linnaea Borealis (L.) *var. americana* (Forbes) Rehd. Twinflower. Rare. There are a few plants among the tamaracks at Pawpaw Lake. It is plentiful in a tamarack swamp south of Little Sugarloaf Lake, scattered in patches over several acres.

Gerardia Gattingeri Small. Gattinger's Gerardia. Very rare. East of Sugarloaf Lake near the railroad. The site is on the border of marsh and higher ground. There is only one other report for Michigan. (Hermann, Rhodora 38:366. 1936.)

To his parents' home, in 1911, Clarence brought his 25-year-old bride, Florence Nutten, second daughter of Professor and Mrs. Albert M. Nutten of Comstock, MI. A Schoolcraft author wrote about the Haneses' courtship as follows:

> In 1909 Clarence Hanes called at the Nutten home to see Albert. His absence was more than compensated by the opportunity to meet Florence. Every Saturday for the next year the young Schoolcraft man took a train to Kalamazoo and an interurban rail car to Comstock. When he proposed, Florence's mother said "Well, marriage will save him 25 cents a week trainfare."
>
> ——Mary Jane Swarts, *Kalamazoo Gazette*, 1960

Florence, too, had prepared herbarium specimens in high school and some of her early sheets are preserved in the Hanes Herbarium at Western Michigan University. In a charming little book that Florence kept as a memento of their wedding trip to Niagara Falls, gentian flowers and ferns are carefully pressed.

When the Great Depression hit, the Haneses bought an evaporator and made maple syrup every winter, a labor-intensive operation. In addition, Clarence did the twice-daily chores on their small farm. Clad in overalls and rubber boots, he was a familiar sight riding his bicycle through the village, a pail of milk swinging in one hand. Eggs, milk and cream were sold from the house along with syrup, vegetables and fruits from their orchard.

In 1933 they started their serious botanical studies with high hopes and one bicycle. When they took their collecting tramps through the countryside, Florence walked and Clarence rode the bike. Later they were given use of an old truck. In the first four years of work, the Hanes couple collected 1400 specimens, a tremendously time-consuming task. Florence must have performed the greater part of the mounting and labeling because her diaries often recorded long hours of intensive work.

Through the years they frequently sent specimens out for confirmation of species by known botanical experts. Acknowledgment is made in the *Flora* of 24 mentors. As early as 1934, there is a scolding letter in the Hanes records from Fernald chastising Clarence for lack of labels on submitted plants.

Dr. Liberty Hyde Bailey was already well established in botanical circles when Clarence sent him his first letter in 1939. Thus began an extensive correspondence, involving both letters and boxes of blackberry specimens. Fred Rapp of nearby Vicksburg was also a *Rubus* student and contributed many findings. Ultimately, Bailey named 14 new *Rubus* species and noted that 22 species of *Rubus* were found only in Kalamazoo County. The type specimens on which the nomenclature of Bailey's new species rests are available in the Hanes Herbarium at Western Michigan University. In this still difficult genus, with its many species and its great variability, it is comforting to know that these type specimens still exist.

Both Clarence and Florence were orchid fanciers and the 29 species listed for the county are still recognized by Dr. Edward Voss in *Michigan Flora*. They did not list an authority for either *Orchis* or *Viola*, so they presumably worked them out by themselves.

The years rolled by filled with farm chores, local school board affairs and always collecting trips, sometimes alone, sometimes with other botanists. Some 50 plants determined to be new to Michigan were identified, reported to the Michigan Academy of Science, Arts and Letters, and deposited in the appropriate herbaria as vouchers.

When it became apparent that they would have to publish *Flora* themselves, they had a last flurry of collecting in 1945. Finally, the manuscript was typed and the copy proofread. Florence's diary entry for Friday, February 28, 1947 reads:

> 6 books came. Probably biggest day of our lives but we are so used to the thought of the Flora that a good deal of the thrill is worn off by all the years of work. The book is all we ever expected it to be—neat, well done and all.

A few days later, "a cold, nasty, blustery day", Clarence found it difficult to haul the first 120 pound box of books home from the freight station in their wheelbarrow.

Five years after Clarence's death in 1956, Western Michigan University gave Florence an honorary Doctor of Science degree. She wrote: "What a pity Clarence couldn't have shared it."

I would like to acknowledge the help given me in preparing this paper by three Western Michigan University Biology professors: Dr. Richard Brewer, Dr. Elwood Ehrle, and Dr. Richard Pippen.

INVITATION TO PARTICIPATE

Future articles already underway for this series will include biographies of L.H. Bailey, Frederick Rapp, and Paul Thompson; further contributions are welcome. For information (and to avoid duplication of effort with other authors), contact Dr. Elwood Ehrle, Dept. of Biological Sciences, Western Michigan University, Kalamazoo, MI 49008.

THE BIG TREES OF MICHIGAN
5. Pinus resinosa Ait.

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The State and National Champion Red Pine is in Gogebic County of Michigan's Upper Peninsula, southwest of Watersmeet, MI, in Section 15 of T43N, R19E.

Description of the species: Pines are members of the pine family, Pinaceae. The genus *Pinus* is distinguished from other genera of the family growing in Michigan by having its needle-like leaves born in clusters or fascicles, with 2–5 leaves per fascicle. Voss (1972) lists three species of *Pinus* in his *Michigan Flora*. The red pine can be distinguished from other native pines which grow in the state by its long (8–15 cm) straight leaves two to a cluster, its cones generally deciduous and subterminal on the branches, and the bark of its older branches and trunk reddish.

Location of Michigan's Big Tree: The State and National Champion red pine stands near the northeast corner of Loon Lake in Sylvania Wilderness Recreation Area of the Ottawa National Forest. To locate the tree take U.S. Route #2 west from Watersmeet, MI about 3.0 miles (4.8 km) to Thousand Lake Road and turn left. Go 3.4 miles (5.5 km) south to the A-Frame building at the Sylvania Wilderness Registration Area. After signing in, drive east 0.8 miles (1.3 km) to a gated trailhead on the south side of the road. Parking is available at the trailhead.

Follow the train 2.0 miles (3.2 km) south to Clark Lake, then 1.0 mile (1.6 km) southeast to the northeast corner of Loon Lake. The tree stands in a grove on a slope above the northeast corner of Loon Lake. It has a yellow core plug four feet above the ground on the east side.

Description of Michigan's Big Tree: The tree has a single, solid healthy trunk. It is a magnificent tree to see. The circumference of the tree at breast height was measured on August 11, 1993 at 124″ (318 cm) [Diameter = 39.5″ (101 cm)]. The crown spread was measured at 60′ (18.3 m), a 38% decrease in crown spread compared to that reported by Thompson (1986). Crown radii were 20′, 23′, 43′ and 34′ (6.1, 7.0, 31.1, and 10.4 m) with the

[1]Deceased 20 September 1994.

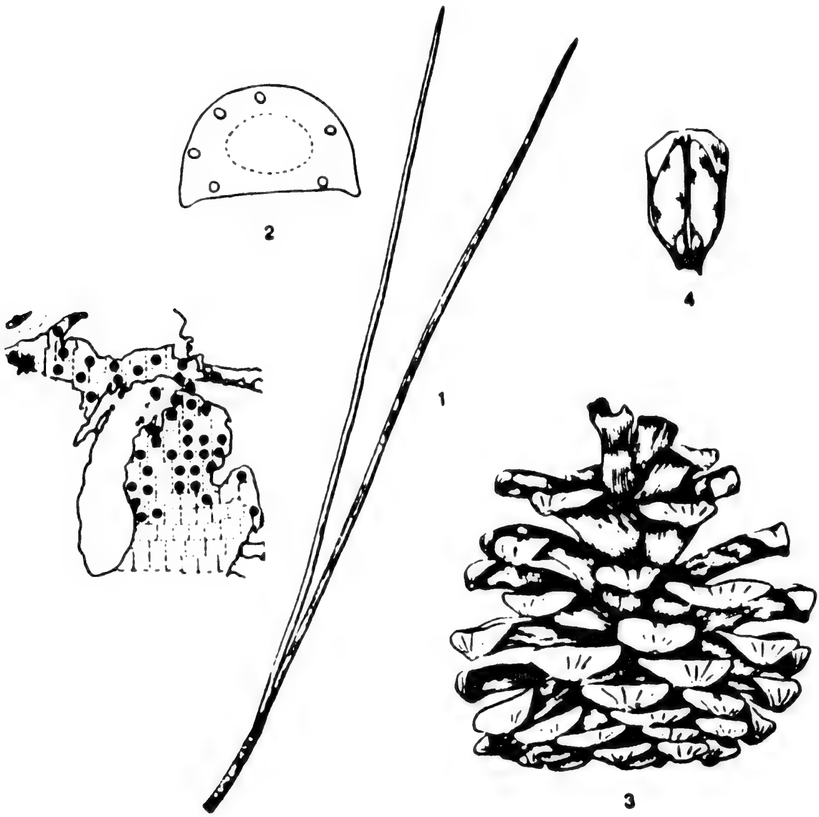

FIGURE 1. Documented distribution in Michigan and characteristics of the red pine. Map is from Voss (1972). The star indicates the location of Michigan's Big Tree. Drawings are from Barnes & Wagner (1981). 1. Cluster of leaves, ×1; 2. Cross section of leaf, enlarged; 3. Opened cone, ×1; 4. Cone scale with seeds, ×1.

largest crown diameter being 77′ (23.5 cm). The height was measured at 124′ (37.8 m), a decrease of 19% from the 154′ (46.9 m) reported by Thompson (1986). The tree is vulnerable to wind gusts and lightening strikes where it stands. No fallen branches were present at its base but these were probably scavenged by campers. The tree appears to be healthy throughout. Since State Champion trees are determined by girth, its State Champion status remains. The reduction in crown size and height, however, may affect its National Champion status.

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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On the cover: Summer habit of the New England violet, *Viola novae-angliae* House. *Photograph by Harvey E. Ballard, Jr.*

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ALBATRELLUS (FUNGI: BASIDIOMYCOTA) IN MICHIGAN

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INTRODUCTION

Albatrellus S. F. Gray is a genus of the family Polyporaceae *sensu lato*. The basidiomes (Figs. 1, 2, 6, 7) typically arise from the forest duff or litter layer, have a central stipe, a pileus 3 to 15 cm diam, and a pore layer on the lower surface of the pileus. Microscopically the basidiospores are broadly ellipsoid to subglobose, up to 7 μm long with hyaline, thin, smooth walls. The hyphae are simple-septate in four of the species and have clamp connections in two species. One species, *A. ovinus*, is edible (Miller & Miller 1980, Lincoff 1989, Phillips 1991, Smith 1975, Smith & Weber 1980), but the palatability of the other species in eastern North America is poor or unknown (Miller & Miller 1980, Smith & Weber 1980).

Macroscopically there are three genera in eastern North America that might be confused with *Albatrellus*. They are *Boletopsis* Fayod, *Jahnoporus* Nuss and *Polyporoletus* Snell. The total number of species in the three genera is five or six. One species of *Boletopsis* and one of *Jahnoporus* occur in Michigan (Gilbertson & Ryvarden 1986). *Polyporoletus* is not known any closer to Michigan than the southern Appalachians of North Carolina. None is common. There are macroscopic features which distinguish these genera from *Albatrellus*. The basidiomes of *Boletopsis* are fleshy and gray to sordid brown, colors which are unlike any Michigan species of *Albatrellus*. *Jahnoporus* has the pileus gray to pale purplish brown and typically hispid. *Polyporoletus* has a chamois-like pileus and large, gray pores. Microscopically the basidiospore features clearly distinguish the three genera. In *Boletopsis* they are nodulose, pale brown *en masse*. In *Jahnoporus* they are large (12.5–17 μm long) and fusiform. In *Polyporoletus* they are large (10–12 × 8–10 μm) and thick-walled, with the walls developing numerous internal cavities.

The principal studies of the species of *Albatrellus* in North America are Overholts (1953), Pouzar (1972), Smith et al. (1981), and Gilbertson and Ryvarden (1986). Overholts described nine species, under the generic name *Polyporus* Fr. Pouzar provided a key to 20 species from the North Temperate Zone, of which 15 were from North America. Smith et al., in an identification manual to non-gilled mushrooms, included seven species of *Albatrellus*. Gilbertson and Ryvarden, in a flora of the North American polypores, treat 12 species. The data on the North American distribution given in these studies vary. Overholts listed the provinces and states from which he had seen specimens and included some literature reports. Smith et al. gave gen-

FIGURES 1 & 2. 1. *Albatrellus caeruleoporus*, AHS 63003. Scale = 2cm.
2. *Albatrellus peckianus*, AHS 62981. Scale = 2cm.

eral distributions, such as "Great Lakes region." Pouzar usually cited the distribution as "North America" or "eastern North America," but in a few cases the names of states were included. Gilbertson and Ryvarden included both a commentary and distribution maps accurate to the province or state level. Additional reports of one or a few species have appeared in field guides and similar books (Lincoff 1989, Miller & Miller 1980, Phillips 1991, Pomerleau 1980, Smith 1975, Smith & Weber 1980). However, the first and only report of *Albatrellus* in Michigan (85°W, 44°N) is that of Povah (1935). His flora of Isle Royale listed a misidentified specimen of *A. ovinus* as *"Polyporus confluens"*.

The habitats and ecological roles of the species are poorly known. For many collections the habitat was simply recorded as "on ground," as the basidiomes of most species arise from the leaf and needle layer on the forest floor. Some species are suspected of forming mycorrhizae with conifers. Gilbertson and Ryvarden (1986) stated "All species have mycorrhizal connections with trees," but Stalpers (1992) found "no indication of mycorrhiza."

The purpose of this note is to document the presence of six species in Michigan, to summarize the knowledge of their habitats and probable ecological roles, to assess their rarity, and facilitate the identification of fresh basidiomes and herbarium specimens.

METHODS

The descriptions appear in alphabetical order by species name. Forty-six Michigan specimens were found and examined. All are preserved in the University of Michigan Herbarium (MICH), unless otherwise stated. Herbarium abbreviations follow Holmgren et al. (1990). Many of the collections cited were made by Alexander H. Smith (AHS) or bear his collection number.

The descriptions are from the 46 dried specimens. Features of fresh basidiomes were taken from notes filed with the specimens. Because only a few specimens had accompanying descriptions of the fresh features, some descriptions are scanty. Colors in quotes are names from Ridgway (1912) and they are from the notes with specimens. The codes in parentheses represent colors from the Munsell Book of Color (Anonymous, 1929–1942). Because the colors of fresh basidiomes are important in the identification of collections, the guides and books which contain satisfactory color photographs are listed under each species. The standard mounting media for microscopic examination of specimens of the Polyporaceae were used, i.e. Melzer's reagent, 2% potassium hydroxide (KOH), and cotton blue in lactic acid. The formulae for these can be found in Boidin (1958), Hawksworth et al. (1983) and Hjortstam et al. (1987). The color reaction of iron salts, $FeSO_4$, on fresh mature tissues was recorded by some collectors. Their notes are reproduced below. The formula and a discussion of the color changes appear in Singer (1986: 102).

KEY TO THE SPECIES IN MICHIGAN

1. When fresh the pileus, pores, and stipe with grayish blue to blue tints .... *A. caeruleoporus*
1. Fresh basidiomes lacking blue tints 2
   2. Basidiomes primarily ochraceous to yellow when fresh, attached to dead hardwoods (esp. stumps and buried roots), pores bright yellow, basidiospores 3.6–4.2 × 2.4–2.8 μm, hyphae with clamp connections .... *A. peckianus*
   2. Fresh basidiomes principally white, grayish white, pinkish white, or pinkish buff 3
3. Fresh basidiomes pinkish white or pinkish buff, herbarium specimens orange to red, clamp connections present, basidiospores faintly to moderately amyloid .... *A. confluens*
3. Fresh basidiomes white to grayish white, herbarium specimens not orange to red, or only faintly pale orange, clamp connections lacking, basidiospores not or moderately amyloid 4

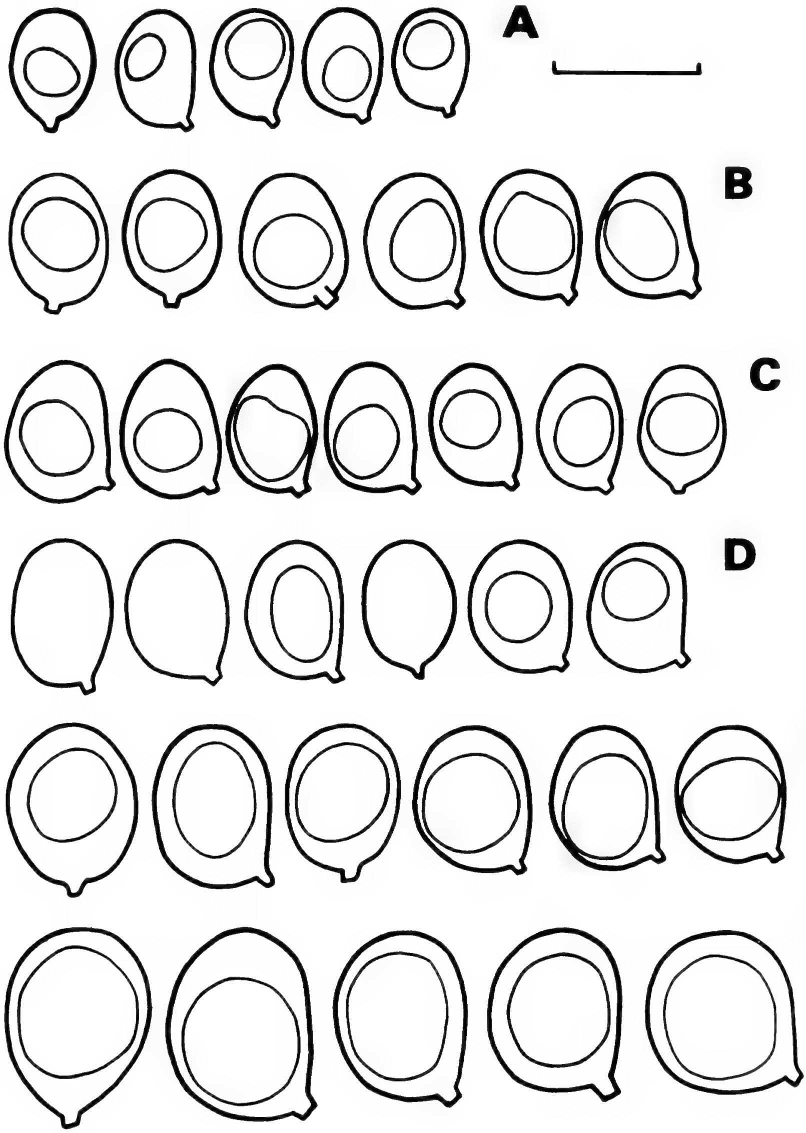


FIGURE 3. Basidiospores. 3A. *Albatrellus peckianus*, AHS 62981. 3B. *A. subrubescens*, IB 3215. 3C. *A. confluens*, KAH 9874. 3D. *A. ovinus*, AHS 38062. 3E. *A. caeruleoporus*, NSW 2646. 3F. *A. cristatus*, AHS 91641. Scale = 5 μm.

4. Basidiomes typically associated with oaks, when fresh staining pale green, pileus cracked to rimose when mature, pores white, basidiospores large, 5.4–6.8 × 4.2–4.8 μm .... *A. cristatus*
4. Basidiomes associated with conifers, when fresh not staining green, pores white but often with yellow stains, basidiospores small, 4.0–4.8 × 3.0–3.6 μm 5
5. Fresh basidiomes staining yellow with an orange tint when bruised, basidiospores moderately amyloid, associated with 2- and 3-needle pines .... *A. subrubescens*
5. Fresh basidiomes staining yellow when bruised, basidiospores not amyloid, principally associated with spruce, infrequently with other conifers, including pine .... *A. ovinus*

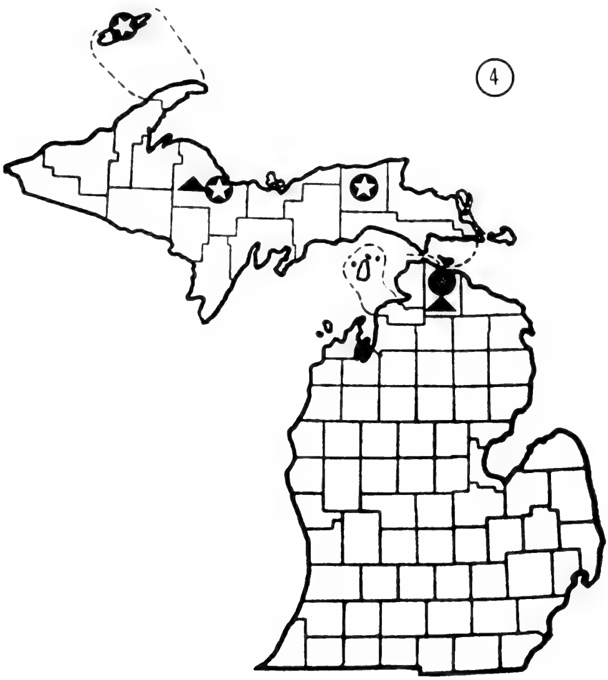
DESCRIPTIONS OF THE SPECIES IN MICHIGAN

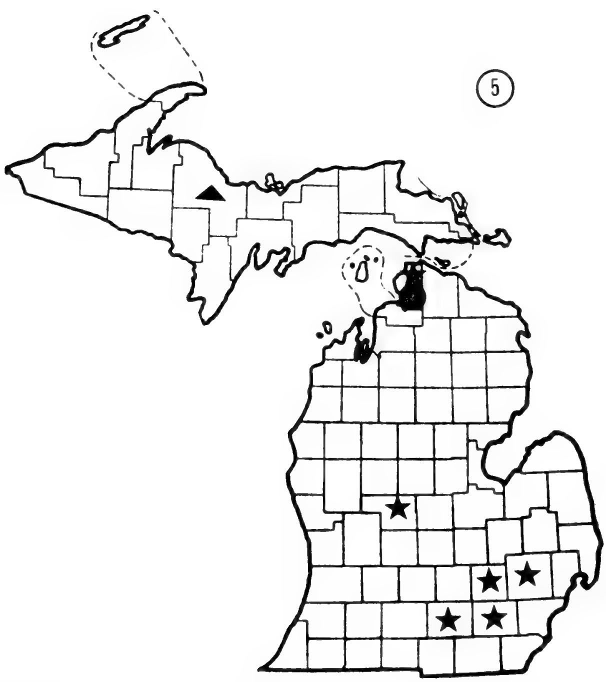
Albatrellus caeruleoporus (Peck) Pouzar Fig. 1
Folia Geobot. Phytotax. (Praha) 1: 358. 1966.
≡*Polyporus caeruleoporus* Peck, Ann. Rep. New York State Mus. 26:68, 1874.

Fresh basidiomes gregarious, grayish blue all over when young, all blue parts staining orange in KOH; pileus becoming violaceous, in age tan to light ochraceous brown, dry; context white, firm, not spongy, not discoloring in KOH, staining pale yellow in $FeSO_4$, odor fragrant, taste slightly fungoid; tubes grayish blue.

Pileus of dried basidiomes 28–100 mm diameter, plane to slightly convex, pigmentation variable, orange-red tinted all over, or ochraceous with faint orange tint, or ochraceous to pallid, or chestnut to tan or pallid, or faintly orange tinted or distinctly orange to orange-red; the surface glabrous, somewhat wrinkled on drying, dull. Context 6–15 mm thick, hard, dense, typically pale orange, but also pallid or orange pink. Tubes pale brown to cinnabar orange (resembling *Pycnoporus cinnabarinus*), 1–2 per mm, some up to 1.5 mm diameter, round to angular, typically slightly elongated radially, extending to the margin of the pileus, tubes 1.5–5.0 mm long, lower edges even, dissepiments thin, in 2646 with scattered incomplete walls (i.e. walls extend from one side of the pore but not reaching the opposite side). Stipe central, infrequently eccentric, up to 27–40 × 10–20 mm, cylindrical, but some either narrowing toward the base or slightly inflated below; exterior glabrous, often with weakly developed network of pores which are either slightly decurrent or rarely extending to the base of the stipe; base slightly tomentose, orange-brown to dark blood red with the basal 5 mm buff color; stipe core solid, color and texture as in context of the pileus.

Hyphal system monomitic. Generative hyphae in context cylindrical, 3–8 (-12) μm diameter, simple-septate, infrequently branched, the walls hyaline, thin (but in 2646, mostly 0.5 μm thick), nonamyloid, with a few granules scattered on the surfaces. Pileipellis of repent, cylindrical hyphae. Tomen-





FIGURES 4 & 5. Distribution of *Albatrellus* species in Michigan. 4. *A. caeruleoporus* (solid circle), *A. confluens* (triangles) and *A. ovinus* (stars). 5. *A. cristatus* (stars), *A. peckianus* (solid circle) and *A. subrubescens* (triangle).

tum at stipe base with hyphal cells cylindrical to slightly clavate, rarely lobed at the apex, the walls irregularly thickened, refractive, pale yellow. Tramal hyphae parallel, 2.5–4.0 (to 5.0) μm diameter, similar to the context hyphae, with numerous amorphous to angular, pale yellow to yellow granules scattered throughout. Subhymenium to 25 μm thick on the older parts of the dissepiment; on young areas the basidia arise directly from the tramal hyphae. Gloeoplerous hyphae not seen. Basidia cylindrical-clavate to clavate, 33–48 × 6–8μm, with (1-) 4 sterigmata, each to 8.5 μm long; two basidia had one sterigma forked with a spore developing at tip of each branch.

Basidiospores (Fig. 3E) broadly ellipsoid, 4.8–5.6 × 3.8–4.2 (to 4.8) μm (n = 39), containing one large oil drop, the walls hyaline, thin, smooth, nonamyloid, with a small but obvious apiculus.

HABITAT: Under mixed conifers including *Tsuga canadensis* and *Pinus strobus* (from notes with 6088). Fruiting in August, September and October.

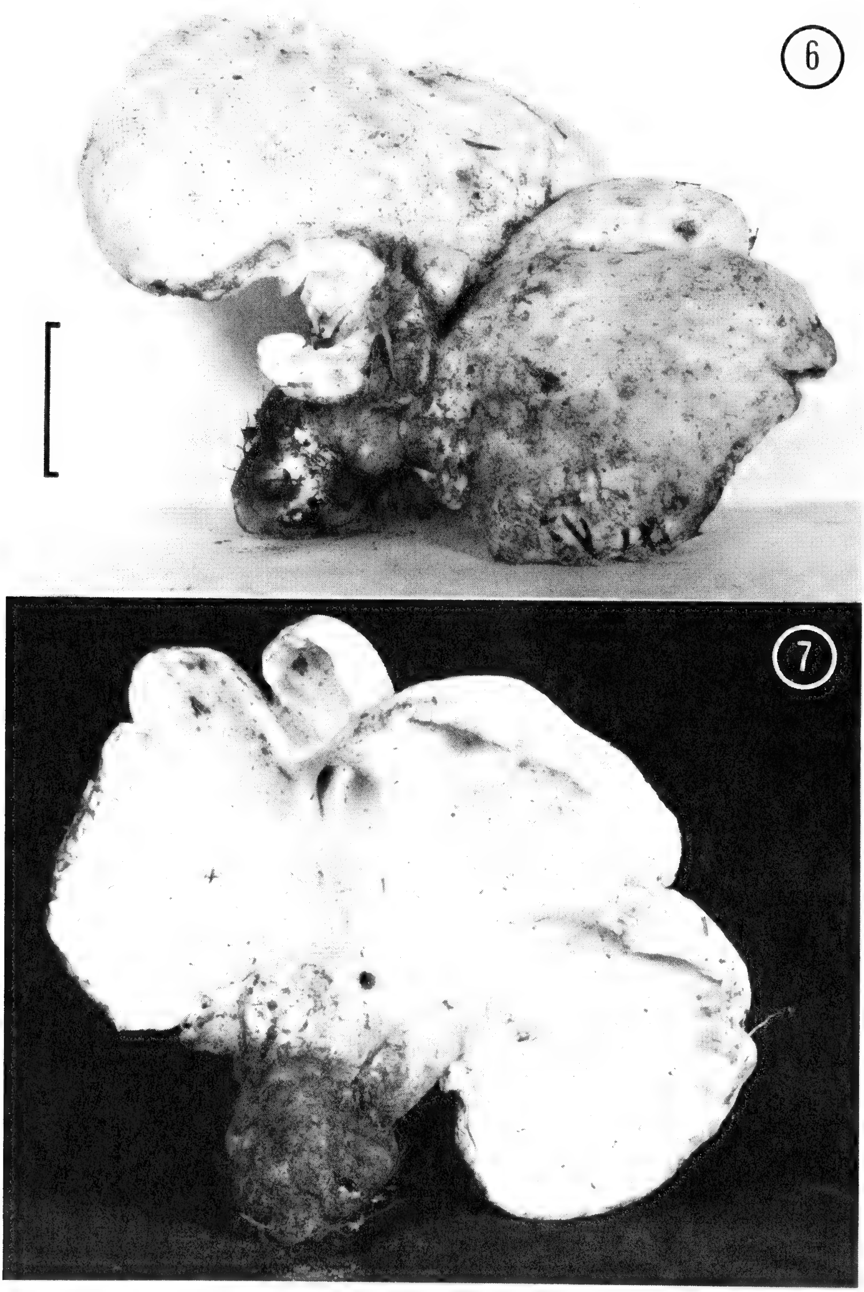
COMMENTS: Color photographs of *A. caeruleoporus* in North America can be seen in Lincoff (1989) and Phillips (1991). This species has been reported from eastern North America as far west as Pennsylvania (Gilbertson & Ryvarden 1986, Overholts 1953). Three collections of *A. caeruleoporus* are known from Michigan; one contained a dozen basidiomes. All three are from the same locality (Fig. 4) and were collected over a 27-year period; presumably the fungus has survived all of that time in that locality. It fruited from mid-August to mid-October. This is apparently a rare species in Michigan.

The principal feature of this species is the overall grayish blue color of fresh basidiomes. This color fades after drying, and most parts of the basidiomes eventually become faintly to distinctly orange to orange-red. The intensity of these necropigments varies between basidiomes of the same and different collections.

Basidiospore sizes seem to be an important taxonomic feature in distinguishing species, but critical, comparative data are lacking. The spore widths in these *A. caeruleoporus* collections were in a narrow range; 32 of the 39 basidiospores measured were from 3.8 to 4.2 μm wide. The spore lengths had a slightly broader range, with 34 of 39 measured being from 4.8 to 5.6 μm long.

Specimens examined: **CHEBOYGAN CO.**: Pellston: Univ. of Mich. Biol. Sta.: The Gorge, 24 Aug 1960, N. Smith & E. Schytema (*AHS 63003*); 19 Oct 1971, *J.A. & N.S. Weber 2646*; 13 Sept 1987, *N.S. & J.A. Weber 6088*.

Albatrellus confluens (Alb. & Schw.: Fr.) Kotlaba & Pouzar
Ceská Mykol. 11:154, 1957.
≡*Boletus confluens* Alb. & Schw., Conspectus Fungorum, p. 244, 1805.
≡*Polyporus confluens* (Alb. & Schw.) Fr., Syst. Mycol. 1:355, 1821.



FIGURES 6 & 7. 6. *Albatrellus confluens*, AHS 72788. Scale = 2 cm. 7. *Albatrellus confluens*, AHS 72788. Scale = 2 cm.

Basidiomes typically gregarious and often with several pilei having their stipes arising from a common base. Pileus when fresh about 100 mm diameter, with the surface dull "Ochraceous-Buff" (Bartelli), glabrous, becoming alveolate; pileus margin obtuse, inrolled. Context firm, becoming lilac in KOH and vinaceous in $FeSO_4$, taste more or less bitter. Tubes white, 6 mm long, mouths minute. Stipe pallid, glabrous, staining olive yellow brown where handled. and tan around larval tunnels. Dried specimens are either entirely orange to intensely orange or tubes and stipe orange and the pileus surface pale tan with only an orange tint.

Hyphal system monomitic. Generative hyphae with clamp connections, the walls hyaline, thin. Pileipellis of cylindrical hyphae 3.0–5.5 μm diameter, the walls thin, nonamyloid or a few cylindrical tips, about 5 μm diameter, with the walls slightly thickened and amyloid. Context hyphae cylindrical (not inflated), 4–7 (to 15) μm diameter, nonamyloid. Tramal hyphae parallel, 2.4–3.6 (to 5.6) μm diameter. Basidia clavate to cylindrical, 15–24 × 4.6–5.6 μm, with 4 sterigmata, each 3 μm long. Basidiospores (Fig. 3C) broadly ellipsoid, 4.0–4.8 × 2.8–3.2 μm (n = 32), containing one large oil drop, the walls hyaline, thin, smooth, weakly to moderately amyloid.

HABITAT: In conifer woods, typically under *Tsuga*, but some collections associated with *Pinus* and *Thuja*. Fruiting in August, September, and October.

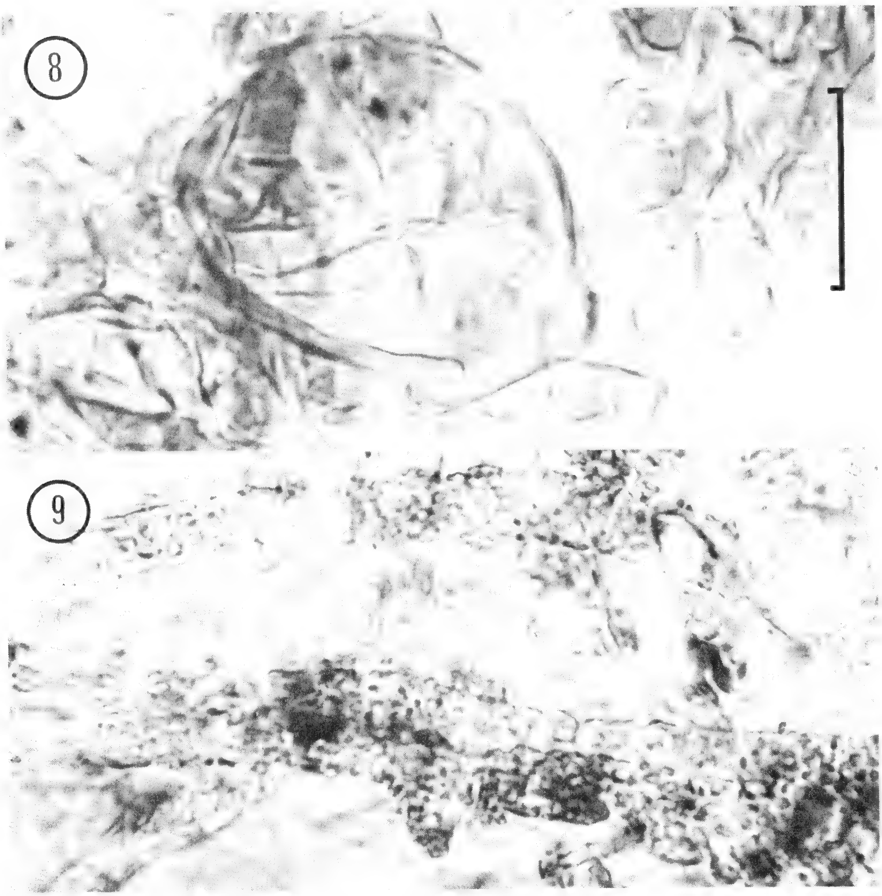
COMMENTS: Color photographs of *A. confluens* in North America can be seen in Miller and Miller (1980), Pomerleau (1980), and Smith (1975). Reported from Isle Royale (Povah 1935), but that collection was misidentified (see *A. ovinus*). Nine collections were found and all were from two northern counties (Fig. 4). The most recent collections were made in 1970, and the current distribution of this fungus in the state is unknown.

The typical amyloid reaction of the basidiospores is a faint bluing that is not obvious in individual basidiospores but can be seen in small groups of six or so overlapping basidiospores. Spore sizes fell within a narrow range; 25 of 32 basidiospores measured were 4.0–4.4 μm long and 21 of 32 were 3.0–3.2 μm wide.

Specimens examined: **CHEBOYGAN CO.**: Burt Lake: Colonial Point, 1 Aug 1951, AHS s.n. (*DAOM 22886*); Pellston: Univ. Mich. Biol. Sta., summer 1951, *D.G. Palmer*. **MARQUETTE CO.**: Huron Mt. Club, Canyon Lake, 29 Aug 1968, *N.J. Smith 1732*; Canyon Lake and vicinity, 7 Aug to 8 Oct 1970, *K.A. Harrison 9241, 9452, 8389, 10034*; near Marquette, 3 Oct 1965, Ingrid Bartelli (*AHS 72788*); Sturgeon River, Route 38, 28 Sept 1970, *K.A. Harrison 9874*.

Albatrellus cristatus (Fr.) Kotlaba & Pouzar
Ceská Mykol. 11: 154, 1957.
≡*Boletus cristatus* Fr., Syst. Mycol. 1:356, 1821.

Basidiomes caespitose, often with several pilei having their stipes arising from a common base; one stipe was branched at 15 and 25 mm above ground line with each branch giving rise to a pileus. Pileus when fresh



FIGURES 8 & 9. *Albatrellus cristatus*. 8. Vesicle from context in congo red, N. Smith 150A. 9. Encrusted, brown hyphae on pileus in water, DAOM F7679. Scale = 20 μm.

tomentose becoming areolate, brownish overall or yellow in center and brown on margin. Context in KOH becoming more or less watery to pale yellowish cream or very faintly yellowish, not reddish, more or less rusty brownish around edge of larval tunnels, odor fungoid, taste mild. Pores white, staining light green to dingy color. Stipe white, stained faintly green.

Pileus of dried specimens 40–70 (to 140) mm diam, plane to slightly depressed, infundibuliform to deeply depressed in the center, in one collection the pileus extremely petaloid with the margin fragmented into nine small, almost imbricate pilei; pileus surface pale brown, olive-brown (10YR6/4–5/4), olive, olivaceous yellow, ochraceous, often with green spots, some with ochraceous or pink in cracks, glabrous to velvety to powdery, dry, dull; margin inrolled to upturned, gray brown to brown. Context up to 20 mm thick, hard, white with some pink patches or with some pink showing through cracks in pileipellis to olivaceous pale pink. Tubes typically cinnabar red, also pale orange yellow, pale yellow tan, deep orange yellow; pores 0.5–2 (to 3) per mm, decurrent, very shallow (0.5 mm), round to angular, fragile, brittle, mouths finely fimbriate; stipe up to 60 × 15 mm.

Hyphal system monomitic. Generative hyphae in the context tortuous, 4.0–8.0 (to 16.0) μm diameter, simple-septate or with the rare clamp connection, the walls hyaline, thin to 0.5 μm thick, a few with scattered amyloid patches; vesicles (Fig. 8) scattered, globose, up to 39 μm diameter, the walls thin to slightly thickened (1 μm) and often amyloid. Gloeoplerous hyphae 4–6 (to 11) μm diameter, scattered, contents intense blue in cotton blue. Pileipellis scalp sections in water not exuding a stain and hyphae with brown encrustations at 800× (Fig. 9), in KOH no stain exuded, the brown color quickly fading, hyphae lacking encrustations, in Melzer's reagent sections quickly darkening and exuding a blue pigment, either no encrustations at 800× or heavily encrusted with granules or plaques of yellow deposits, the hyphae 4.0–8.0 μm diameter, the walls thin to 0.5 μm thick, nonamyloid or with a few hyphal tips weakly amyloid. Tramal hyphae parallel, cylindrical, 3–5 μm diameter, simple-septate, nonamyloid. Basidia clavate, 20–42 × 6.0–7.4 μm, sometimes with an elongated base (to 31 μm), with four sterigmata, each 3.2–3.6 μm long. Basidiospores (Fig. 3F) broadly ellipsoid, oblong, subglobose, containing one large oil drop, 5.4–6.8 × 4.2–4.8 μm (n = 72), the walls hyaline, thin to 0.5 μm thick as seen in cotton blue, smooth, weakly amyloid when viewed *en masse*.

HABITAT: Under hardwoods, with a distinct preference for oaks. Fruiting from July into October.

COMMENTS: A color photograph of *A. cristatus* in North America can be seen in Lincoff (1989). The reports closest to Michigan are from Indiana, Ohio and Wisconsin (Gilbertson & Ryvarden 1986, Overholts 1953). This is the most common species of *Albatrellus* in Michigan, assuming that herbarium records accurately reflect its occurrence in nature. The collections were, with three exceptions (Emmet Co.), from the southern half of the State (Fig. 5). Most were from Oakland and Washtenaw Counties, which is probably a reflection of the proximity of the mycologists at the University of Michigan. In Michigan and in Europe (Ryvarden & Gilbertson 1993) *A. cristatus* is typically associated with *Quercus*.

Albatrellus cristatus resembles *A. peckianus* in shape and color. *Albatrellus peckianus* differs in having smaller spores and clamp connections. Fused pilei and stipes were not uncommon and occur in most species of *Albatrellus*. Many herbarium specimens, especially those stored with naphthalene, had developed cinnabar red necropigments in the tube layer. This intense color, which contrasted with the olive brown color of the pileus, seems to be a useful feature in identifying unnamed herbarium collections. However, in some herbarium specimens the tube layer lacked any red tints.

The pale yellowish cream discoloration of the fresh context in KOH was observed by J. Ammirati (notes with collection 2428). It varies from Lincoff (1989) who reported flesh (context) slowly turning reddish in KOH, and Gilbertson and Ryvarden (1986) who stated "context and tramal tissue turning pale red in KOH." Presumably the latter are referring to microscopic mounts from dried specimens.

The amyloidity of the basidiospores was not obvious in individual spores, but when a cluster of overlapping spores was viewed in Melzer's a faint blue color was detected. The hyphae are typically thin-walled with some having walls to 0.5 μm thick. Gilbertson and Ryvarden (1986) describe some hyphae as "thick-walled," but I did not find any of these.

The basidiospores in collection 150A were a micron longer (6.6–7.2 μm, n = 10) than basidiospores in the other Michigan collections. This collection, 150A, had all the tissues tinted olivaceous, a feature which also distinguished it from the other collections.

Specimens examind: **EMMET CO.**: near Mackinaw City, 15 July 1949, *D. Stuntz (5209)* and *AHS 32529* (WTU); Mackinaw City Hardwoods, 5 Aug 1961, *N.J. Smith 150A*; Wilderness State Park, 11 July 1949, *P. Harding 156*. **JACKSON CO.**: Jackson, 16 July 1942, *AHS 18440*. **LIVINGSTON CO.**: E.S. George Reserve, 11 July 1967, *R. Zehner 60* and *F. Hoseney 512*. **MONTCALM CO.**: Vestaburg: Cook Lake, 18 & 29 Sept 1961, *V. Potter 13200 & 13346*, respectively. **OAKLAND CO.**: Haven Hill (HH), 31 Aug 1968, *J.F. Ammirati 2428*; HH, 20 Sept 1981 *AHS (91407)* & C. Ovrebo; HH, 8 Oct 1981, *AHS 91664*; Kent Lake, 17 Sept 1938, *AHS 10992*; La Badie, 18 Aug 1937, *AHS 7060*; Proud Lake, 23 Aug 1937, *AHS 7192*. **WASHTENAW CO.**: Ann Arbor (AA), July 1932, *AHS s.n.* (DAOM F7679); AA, Golf course woods, 15 Aug 1973, *AHS 84435*; AA, Arboretum, Jul-Aug 1932, *AHS s.n.*; AA, Cascade Glen, Sept 1932, *AHS s.n.*, and 9 Aug 1937, *AHS 6908*; AA, Chubb Road woods, Aug 1915, *C.H. Kauffman*; AA, School Girl's Glen, 10 Aug 1923, *C.H. Kauffman*; AA, Horner Woods, 6 Oct 1981, *AHS 91641*; Crooked Lake, west side, 11 & 19 Aug 1973, *C. Nimke 409 & 481*, respectively; Mill Lake, 16 Sept 1972, *N.S. Weber 3708*; Stinchfield Woods, 20 Aug 1968, *AHS 76044*; Whitmore Lake, 26 Sept 1921, *D.V. Baxter 5961*, Whitmore Lake, Mud Lake swamp, 21 July 1929, *AHS s.n.*

Albatrellus ovinus (Schaeff.: Fr.) Kotlaba & Pouzar
Ceská Mykol. 11:154, 1957.
≡*Boletus ovinus* Schaeff., Fungorum Bavaria 4:83, 1774.

Fresh basidiomes often gregarious, 70–90 mm diameter, typically grayish white. Pileus light brown or light brown with an olive tinge in center, some with fine, near "Mikado Brown" scales; margin paler, edge of pileus and elsewhere turning yellowish green where bruised. Context white tinged slightly yellowish or staining yellow, especially where cracked and around larvae holes. Pores with a decided yellowish tinge or creamy with yellowish stains. Stipe concolorous with hymenium, staining yellow, especially around larvae holes.

Dried basidiomes overall dingy gray-brown or dingy gray, glabrous. Context with patches of orange, up to 7 mm thick. Stipes with traces or patches of orange at base.

Hyphal system monomitic. Generative hyphae in context 5–16 μm diameter, simple-septate, the walls hyaline, thin, nonamyloid. Stipe surface hyphae with scattered, cylindrical hyphal tips, 5–10 μm diam, the walls thick, amyloid. Tramal hyphae simple-septate, 2.8–4.8 μm diameter. Basidiospores (Fig. 3D) broadly ellipsoid, infrequently subglobose, 4.0–4.8 × 3.2–3.6 μm (n = 23), containing one large oil drop, the walls hyaline, thin, smooth, nonamyloid.

HABITATS: Mixed forest (some *Tsuga canadensis* needles attached to the specimen), on soil in conifer forest, under *Picea* and fir (presumably *Abies*) forest. Fruiting in August, September, and October.

COMMENTS: Color photographs of *A. ovinus* in North America can be seen in Lincoff (1989), Miller and Miller (1980), Phillips (1991), Pomerleau (1980), Smith (1975), and Smith and Weber (1980). Similar to *A. subrubescens* and *A. confluens* when fresh, but the latter is tinted pink. Orange tints were consistently present at the base of the stipes of dried specimens; perhaps they are a useful taxonomic feature.

The reports closest to Michigan were from Ontario, Canada, and Wisconsin (Gilbertson & Ryvarden 1986, Overholts 1953). In Michigan *A. ovinus* is known from four collections, all from the Upper Peninsula (Fig. 4); the most recent was made in 1967. Thus the current status in Michigan is uncertain. It was surprising that so few collections were found, because *A. ovinus* is considered to be the most widespread and abundant of the *Albatrellus* species (cf. Lincoff 1989). Perhaps it is because the basidiomes are collected for food. Apparently *A. ovinus* is an uncommon species in Michigan.

The habitat data are from the Michigan specimens. Habitat data from North America are sparse and general; e.g. see Gilbertson and Ryvarden (1986). However, in Europe, *A. ovinus* is typically associated with spruce (Ryvarden & Gilbertson 1993).

Specimens examined: **KEWEENAW CO.**: Isle Royale National Park: Mott Isle, 15 Oct 1942, *H. & V. Bailey 166*; Isle Royale: Tobin Harbor, 14 Aug 1930, *J.L. Lowe & C.A. Brown, Fl 247*. **LUCE CO.**: Tahquamenon Falls State Park, 31 Aug 1951, *AHS 38062*. **MARQUETTE CO.**: Huron Mountain Club: Ski Basin, 10 Sept 1967, *K.A. Harrison 7027*.

Albatrellus peckianus (Cooke) Niemelä
Ann. Bot. Fenn. 7:54, 1970.
≡*Polyporus peckianus* Cooke, Trans & Proc. Bot. Soc. Edinburgh 13:148, 1879.

Dry basidiomes about 60 mm diameter. Pileus surface ochraceous to pale yellow, glabrous, dull, plane to somewhat depressed. Context 4 mm thick, pallid. Pores 3 per mm, angular, pale yellow to yellow, brittle; tubes 2.5 mm long, dissepiments thin, mouths weakly fimbriate. Stipe central or infrequently eccentric, cylindrical, about as long as the pileus is wide.

Hyphal system monomitic. Generative hyphae with clamp connections. Tramal hyphae parallel, 3–4 μm diameter, the walls thin, hyaline, nonamyloid. Stipe hyphae 4–6 μm diameter, the walls thin to 1.5 μm thick, hyaline, nonamyloid. Basidia cylindrical-clavate, 16–18 × 5.2–6.0 μm, with 4 sterigmata. Basidiospores (Fig. 3A) broadly ellipsoid to oblong, 3.6–4.2 × 2.4–2.8 μm (n = 5), containing one large oil drop, the walls hyaline, thin, smooth, nonamyloid. Spore print buff color.

HABITAT: On and around hardwood stump. Fruiting in August.

COMMENT: A color photograph of *A. peckianus* in North America can be seen in Phillips (1991). Prior reports closest to Michigan were from Ontario, Canada, and Wisconsin (Gilbertson & Ryvarden 1986, Overholts 1953). Known in Michigan from only one collection in the northern part of the State (Fig. 5). My observations (unpubl.) in western Quebec, as well as literature reports (loc. cit.), indicate that this species inhabits dead stumps and dead buried roots of hardwoods. Because *A. peckianus* inhabits dead wood and readily grows *in vitro* (Ginns, unpubl.), it is unlikely that the species is mycorrhizal.

Specimen examined: **EMMET CO.**: Pellston Hills: west of Pellston, 23 Aug 1960, *AHS 62981*.

Albatrellus subrubescens (Murr.) Pouzar
Ceská Mykol. 26:196, 1972.
≡*Scutiger subrubescens* Murr., Bull. Torrey Bot Club 67:277, 1940.

Basidiomes gregarious, white when fresh and distinguishable from *A. ovinus* with difficulty. Dried specimens like *A. ovinus*, but pores brownish orange.

Hyphal system monomitic. Context hyphae 4–13 μm diameter, simple-septate, the walls hyaline, thin, nonamyloid. Gloeoplerous hyphae present but infrequent in both context and trama, up to 8 μm diameter, with yellow oily contents. Pileipellis scalp sections show hyphae thin-walled and many weakly amyloid. Basidia clavate, about 23 × 6.4 μm, with 4 sterigmata. Basidiospores (Fig. 3B) broadly ellipsoid, some narrowing slightly toward the apex, 4.0–4.6 (to 5.0) × 3.0–3.4 (to 3.8) μm (n = 21), with one large oil drop, the walls hyaline, thin, smooth, amyloid.

HABITAT: Under *Pinus*. Fruiting in September.

COMMENT: Previously reported in northeastern North America from Manitoba, New York, Quebec, and Wisconsin (Pouzar 1974). Known in Michigan from only one collection made 25 years ago in the Upper Peninsula (Fig. 5).

Albatrellus subrubescens is very similar to *A. ovinus* and in the field easily confused with it. Pouzar (1974) discussed the differences between *A. ovinus* and *A. subrubescens* in the coloration which developed when fresh basidiomes were bruised. *Albatrellus ovinus* stains yellow, whereas *A. subrubescens* stains yellow with an orange tint. Pouzar concluded that, with experience, it was possible to identify specimens of both species in the field, but the macroscopic features were not reliable in some collections. The brownish orange color of the pores of herbarium specimens may be useful in distinguishing *A. subrubescens* from *A. ovinus*, which has dingy gray brown pores. The most distinctive feature is the amyloid basidiospores in *A. subrubescens*. Basidiospores in Melzer's show a hyaline wall 0.4 μm thick and a blue interior. Thus the amyloid material coats the inner surface of the wall.

Albatrellus subrubescens is associated with 2- and 3-needle pines (Pouzar 1974, Ginns unpubl.), whereas *A. ovinus*, although typically associated with spruce (Ryvarden & Gilbertson 1993), has been found under *Abies balsamea* and *Pinus banksiana* (Ginns unpubl.).

Specimen examined: **MARQUETTE CO.:** Huron Mountain Club, 25 Sept 1968, *Ingrid Bartelli 3215*.

DISCUSSION

Twelve species of *Albatrellus* occur in Canada and the United States (Gilbertson & Ryvarden 1986). Until now only one species had been reported from Michigan. Povah (1935) listed "*Polyporus confluens*" from Isle Royale, but the specimen which was the basis of the report has been redetermined, above, to be *A. ovinus*. Nevertheless, *A. confluens* and five other species are herein documented from Michigan. In addition, the known distribution and habitats of *A. ellisii* (Berk.) Pouzar and *A. pes-caprae* (Pers.:Fr.) Pouzar, two uncommon species, suggest they could be in Michigan. *Albatrellus cristatus* is the most common species in the state, being known from 28 collections. Three species, *A. caeruleoporus, A. peckianus*, and *A. subrubescens*, are known from only one locality each. They are considered to be rare in Michigan.

Although based upon few collections, the distributions within Michigan suggest that five species prefer the more boreal forests of northern Michigan (Figs. 4 & 5). *Albatrellus cristatus* is typically associated with oaks. *Albatrellus subrubescens* is associated with 2- and 3-needle pines. In addition, *A. peckianus* has the basidiomes attached to the base of dead stumps and buried dead roots of hardwood species, which suggests it decays the wood. The role of these species in nature remains imperfectly known. Thus, the frequency, geographical distribution, and ecological role of the species of *Albatrellus* in Michigan require additional documentation. To facilitate the gathering of data on *Albatrellus* species, a key, which emphasizes the identification of specimens in the field, has been included.

ACKNOWLEDGMENTS

A grant from the Alexander H. & Helen V. Smith Research Fund to study at the University of Michigan Herbarium in 1992 supported the completion of this study. The Herbarium (MICH) made available the negatives for figures 1, 2, 6, and 7. Drs. R. Shaffer and R. Fogel provided valuable assistance during my visit to the Herbarium.

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THE BIG TREES OF MICHIGAN
6. Magnolia acuminata (L.) L.

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The State Champion cucumber-tree is near the southern edge of Berrien County of Michigan's Lower Peninsula, SSE of Dayton, MI, in section 20 of T8S, R18W.

Description of the species: Magnolias are members of the Magnolia family, Magnoliaceae. The family can be distinguished from other dicot families by large showy flowers with numerous separate stamens and numerous separate carpels. The family is represented in Michigan by the tulip-tree (*Liriodendron tulipifera* L.) and several species of magnolia. Tulip-trees can be recognized by their broadly truncate leaves and their large yellow-green flowers which are orange within. Magnolia leaves are entire, oblong-ovate to broadly oval, and the flowers are white, yellow, rose, or purple. Most magnolias in Michigan are introduced. The most commonly planted are the saucer magnolia (*Magnolia soulangeana* Soul.) which is a tree with large flowers, purplish or rose-colored outside and white within, appearing before the leaves; and the star magnolia (*Magnolia stellata* Maxim.) which is usually a shrub with large white flowers that appear before the leaves. In contrast to these, the cucumber-tree has large flowers which are yellow-green inside and out and which are produced at the same time as the leaves (Fig. 1). The cucumber-tree has leaves which are generally 6–10″ (15–25 cm) and may be up to 13″ (33 cm) long, considerably larger than those of most other Michigan trees.

Location of Michigan's Big Tree: The State Champion cucumber-tree stands in front of a farm house at 3110 Spirea Road in Bertrand Township, approximately 0.2 miles (350 yards = 320 m) north of the Indiana State Line. The tree can be reached by taking Rt. 12 from the south side of Dayton, MI (corner of Dayton Rd. & Rt. 12) approximately 1.5 miles (2.4 km) east to Sage Road. Turn right and take Sage Road SSW 0.6 miles (0.97 km) to Buffalo Road and turn right. Go 0.6 miles SW to Spirea Road and turn left. Go 1.3 miles (2.1 km) on Spirea Road to the farmhouse on the west side of the road at #3110.

Description of Michigan's Big Tree: The tree has a single, solid, healthy trunk and a rounded crown. It is a magnificent tree to see. The circumference of the tree at breast height was measured on August 22, 1993 at 164″ (417 cm) [Diameter = 52″ (132 cm)]. The crown spread was measured at 75′ (22.8 m), a decrease of 18′ (5.5 m) or 24% from the 93′ (28.3 m) reported by Thompson (1986). Crown radii were 41′, 38′, 32′, & 38′ with the largest crown diameter being 79′ (24.1 m). The height was measured at 70′ (21.3

FIGURE 1. Documented distribution in Michigan and characteristics of the cucumber-tree. The star indicates the location of Michigan's Big Tree. Drawings are from Brown (1938). 1. Twig with flower and mature leaves, × 1/2; 2. Lateral view of flower, sepals & petals removed, × 1; 3. Cone-like fruit of coalescent follicles, × 1/2; 4. Drupaceous seed, lateral surface view, × 1 1/2; 5. Drupaceous seed, lateral sectional view, × 1 1/2; 6. Seed with outer fleshy integument removed, × 1 1/2; 7. Winter twig, × 1/2.

m), nearly the same as the 75′ (22.8 m) reported by Thompson (1986). The tree is healthy and shows no signs of recent damage. The first branch occurs 8′ (2.4 m) from the ground. Voucher specimens are being prepared for deposition in the herbaria at the University of Michigan (MICH), Michigan State University (MSC), and Western Michigan University (WMU).

It is uncertain whether this Champion is a native tree or was planted. In discussing magnolia, Voss (1985) reports that ". . . there are no records . . . of any native species occurring in the state, although *M. acuminata* (L.) L., "Cucumber-tree," grows as close as northeastern Ohio and southern Ontario." Barnes & Wagner (1981) indicate that it is ". . . a native of Ohio and adjacent regions to the east." The senior author (EBE) has seen it growing natively at several locations in Indiana. On the one hand, its nearby native distribution suggests that this Champion is a native tree. On the other hand, it does occur in the front yard of a farmhouse. If it is a planted tree, it was planted long ago, perhaps before the current farm house was built!

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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REVIEW

MICHIGAN NATURE ASSOCIATION NATURE SANCTUARY GUIDEBOOK, 7th Edition. Edited by Richard W. Holzman, Bertha A. Daubendiek, Lyle Rizor, Forbes Sibley. Michigan Nature Association, Box 102, Avoca, Michigan 48006. 1994. 128 pp. $29.00 ppd.

Between the beautiful color photos on front and back covers, this volume includes an abundance of photos (black and white) of Michigan plants and animals—many of them rare—as well as scenes of choice wild spots in the diverse sanctuaries owned by the Michigan Nature Association. Altogether, 77 sanctuaries ("categories A and B") are described in some detail with small maps and/or directions. These are generally the most accessible (and larger) ones.

The 63 "category C" sanctuaries and preserves of the MNA are listed but not described. They average much smaller (even as small as 0.1 acre), often designed to protect a single species, and "cannot be visited without a guide." Visitors are, however, welcome to enjoy the others, so long as they follow the rules about non-destructive behavior. These include excellent advice to "watch where you walk to avoid crushing plants"; "Photographers must avoid harming plants. Birdwatchers should watch where they are stepping." So it is a little odd to see so many pictures (e.g., on pp. 3, 34, 46, 97, 114) of people kneeling, sitting, or even lying immediately adjacent to rare plants.

This is much more than just a guide to the MNA sanctuaries, which are found throughout the state. Readers will find a great deal of history, both of MNA and of various sites, which it is valuable to have thus recorded. The volume abounds with case histories of various types of land acquisition and easements that can be used to protect land. Browsing and enjoying the descriptions and pictures would be a fine way to spend a stormy evening indoors in anticipation of a day in the field. Critical nit-picking proofreaders (like this reviewer) will shudder a little from time to time over misspelled names of persons and organisms and other glitches (like the assertion that thimbleberry is "never found in the Lower Peninsula"). And skeptics may wonder at claims to have *Gentiana amarella* and *G. clausa* on MNA property; I know of no documentation that either gentian has ever occurred anywhere in or very near Michigan and hope for enlightenment in time to add them to the final volume of *Michigan Flora*.

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COMMENTS ON SOME INTRODUCED CARYOPHYLLACEAE OF OHIO AND NEARBY STATES

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ABSTRACT

The first collections of seven species of Caryophyllaceae are reported from four states: Indiana (1 species), Kentucky (3), Ohio (5), and West Virginia (2). New county records for eight species are reported from five states: Indiana (3 species), Kentucky (2), Michigan (6), Ohio (1), and West Virginia (2). *Moehringia trinervia* (L.) Clairv. is reported for the first time in North America. The author citation for *Stellaria pallida* is corrected.

INTRODUCTION

Winter annual and early annual members of the Caryophyllaceae have often been overlooked in the North American flora. Some taxa, e.g., four of the five *Cerastium* species discussed here and *Stellaria pallida* (Dumort.) Junger, resemble very widely distributed weedy species, in this case, *Cerastium fontanum* Baumg. emend Jalas and *Stellaria media* (L.) Villars respectively. Botanists may see them and assume that these plants are already known from an area. Other taxa, e.g., *Holosteum umbellatum* L., complete their life cycle in early spring before most field investigations begin.

Many of the records that follow were gathered in an attempt to "correct" this situation, proving that the species are more widely distributed than recent literature suggests. Our initial efforts were centered on gathering Ohio records, where five species missing from recent floristic lists (Cusick & Silberhorn 1977, Weishaupt 1971) were documented, expanding to other states as additional collections were made and herbaria examined. We cite the first collection made and/or seen from each county; when there are additional collections, the number of different collections examined is given within the brackets immediately following the county name. Herbarium abbreviations follow Holmgren et al. (1990) except gc (Georgetown College herbarium, Georgetown, KY) and jkm (the personal herbarium of Dr. John K. Morton).

CERASTIUM

Cerastium brachypetalum Pers.

This annual species of *Cerastium* barely enters our region from the south where it has become established in disturbed areas in Virginia (Harvill et al. 1986), the Carolinas (Radford et al. 1968), extreme western and southeastern Kentucky (Browne & Athey 1992), central Tennessee (Wofford 1980), and northern Arkansas (Smith 1988). It resembles the widespread *Cerastium fontanum*, mouse-ear chickweed, but can be recognized by the entirely herbaceous inflorescence bracts which, along with the sepals and the upper stem, are covered by long, yellowish, mostly eglandular hairs.

The northernmost collections which we know of are from populations in southern Illinois (Mohlenbrock 1986, Shildneck & Jones 1986) and West Virginia (Rabeler 1990; a collection from a second county is cited below), and now in extreme southern Indiana and eight northern and western Kentucky counties. Although absent from a recent list of new records from Floyd and adjacent Indiana counties (Maxwell et al. 1991), it should be expected at other disturbed sites along the Ohio River, especially roadsides and croplands.

INDIANA. FLOYD CO.: roadside, 2 km N of Greenville, 9 May 1953, *Buser & Ahles 3570* (IND, MICH; 2nd sheet at IND is *C. glomeratum*).

KENTUCKY. BOONE CO.: fallow field, ca. 13 km W of Union, 12 May 1985, *Thieret 56067* (KNK). BOURBON CO.: roadside, Paris, 3 May 1992, *Thieret 57260* (KNK). CAMPBELL CO.: railroad yard, Silver Grove, 20 May 1984, *Thieret 55059* (KNK). GALLATIN CO.: weed in nursery, Warsaw, 3 May 1985, *Thieret 56038* (KNK). KENTON CO.: railroad yard, ca. 3 km S of Latonia, 8 May 1985, *Thieret 56066a* (BRIT, KNK, MICH). MASON CO.: roadside, KY 8, ca. 10 km NW of Maysville, 6 Apr 1985, *Thieret 56001* (KNK). SPENCER CO.: fallow field, KY 155, 5 km NW of Elk Creek, 27 Apr 1994, *Thieret 57220* (KNK, MICH). TRIGG CO.: Cave Spring Church lawn, N of KY 124, Cerulean, 4 Apr 1994, *Cusick 31474* (MICH).

WEST VIRGINIA. CABELL CO.: picnic area, Rotary Park, W of US 60 & S of 8th Ave., Huntington, 5 May 1994, *Cusick 31581* (CM, MICH, VPI).

Cerastium dubium (Bast.) Guépin

The winter annual *Cerastium dubium* appears to be a recent addition to the flora of eastern North America. Shildneck and Jones (1986) reported it from soybean and corn fields in two central Illinois counties, the first collections made in 1980. Rabeler & Smith (1993) reported *C. dubium* as new to Arkansas where it was first gathered in 1982. This species can now be added to the flora of Kentucky.

Although seldom seen (thus far), it is easily separated from the other introduced *Cerastium* species by the combination of linear to spathulate leaves, herbaceous inflorescence bracts, petals about 1.5 × longer than the sepals, 3 (or sometimes 4) styles, and a capsule opening by 6 (sometimes 5, 7–8) apical teeth. The 3-styled condition is quite rare in *Cerastium*; *C. cerastioides* (L.) Britt., a species of the eastern Arctic, is the only other species in North America regularly exhibiting this feature.

KENTUCKY. BULLITT CO.: weedy plant nursery, 5 km S of Shepherdville, 27 Apr 1994, *Thieret 57244* (KNK, MICH).

Cerastium glomeratum Thuill.

Clammy chickweed, although rarely found in much of our area, is common in disturbed areas in the southeastern United States north to the southern portions of Illinois, Indiana, and Ohio (Rabeler 1988b). This species is distinguished by a dense inflorescence with flowers on pedicels usually shorter than the calyx, herbaceous bracts, and mostly eglandular hairs on the sepals which extend beyond the sepal apices.

First collected in Washtenaw County in 1978 and then in Ingham County in 1985–1986 (Rabeler 1988b), *C. glomeratum* is now known from two additional Michigan counties. It remains the least common of the introduced *Cerastium* species in Michigan.

MICHIGAN. CASS CO.: sandy roadside, S side of M-205, 0.15 km SW of US 12 & M-205 jct., SW 1/4, Sec. 16 of T8S, R14W, 14 May 1994, *Rabeler 1169* (MICH). ST. JOSEPH CO.: sandy roadside, SW corner of Buchanan and S. Railroad, 1 block S of M-60 (Main St.), Mendon, SW 1/4, Sec. 27 of T5S, R10W, 14 May 1994, *Rabeler 1166* (MICH, MSC).

Cerastium pumilum Curtis and *Cerastium semidecandrum* L.

Cerastium pumilum (Curtis' mouse-ear chickweed) and *C. semidecandrum* (small mouse-ear chickweed) are two annual species that appear to be much more widely distributed than major floristic manuals indicate. Both prefer sandy or gravelly disturbed areas and often occur together in our area, e.g., *Rabeler 996, 997, 1129, 1142B, 1171, Thieret 57308a* (pumilum), *996A, 998, 1129A, 1142A, 1172, Thieret 57308b (semidecandrum)*; either may be the more abundant at a site. Areas to look for them include parking lot and sidewalk edges, roadsides, railroad crossings, cemeteries, and waste areas that escape early mowing where likely associates include other early spring Caryophyllaceae taxa, e.g., *Arenaria serpyllifolia* L., *Holosteum umbellatum*, and *Stellaria pallida. Cerastium pumilum* and *C. semidecandrum* are early annuals, maturing in late April through May with all but the earliest collections bearing at least one ripe capsule. Both may occasionally be found alive in early summer, e.g., *Rabeler 1134* on 27 June (*C. pumilum*; Steuben Co., NY) and *Rabeler 1151* on 18 July (*C. semidecandrum*; Oceana Co., MI), with growth sometimes arising from axillary buds of mowed plants. As noted by Rabeler (1988a), the seed surface, petal venation, and width of the scarious margin of the uppermost inflorescence bracts are diagnostic in separating the taxa.

Cerastium pumilum Curtis

The documented range of this species in eastern North America has expanded greatly since 1988. When Rabeler (1988a) reported this species as new to Michigan, he noted that *C. pumilum* had also been reported in recent floras from Illinois, Maryland, Missouri, New Jersey, Ontario, and Pennsylvania. This list can now be corrected and expanded. Pennsylvania should be deleted from the list because the voucher specimen for the Berks County record, *Wilkens 12980* (PENN) (Wilkens 1975), is a collection of *C. semidecandrum*; the species appears in Rhoads and Klein (1993) under "Excluded Species." Subsequent studies cited specimens of *C. pumilum* from Arkansas, North Carolina, South Carolina, Tennessee, and Virginia (Rabeler & Thieret 1988), Connecticut and Massachusetts (Angelo 1990), Kentucky (Browne & Athey 1992), New York (Mitchell 1993), and Indiana (Swink & Wilhelm 1994).

Our collections allow the addition of Ohio and West Virginia to the above list as well as county records in Indiana, Kentucky, and Michigan. The presence of this species in at least 18 Ohio counties reinforces the idea of its being a widely distributed, but overlooked, plant.

OHIO. ASHTABULA CO. [2]: Walnut Beach Park, N of Walnut Blvd., Ashtabula, 4 May 1993, *Cusick 30781* (CLM, OS). CUYAHOGA CO.: weedy strip along Cuyahoga River, foot of Superior Ave., Cleveland, 7 May 1993, *Cusick 30818* (MICH). DEFIANCE CO.: limestone ballast, SE of CSX RR crossing, US 127 (Harrison St.), Sherwood, SW 1/4, Sec. 18 of T4N, R3E, 14 May 1994, *Rabeler 1183* (MICH, MU). ERIE CO. [2]: weedy lot, Shelby & Water sts., Sandusky, 19 May 1992, *Cusick 30227* (MICH, OS). FRANKLIN CO. [3]: vacant lot between 5921 & 5945 N High St., 1 mi S of US 23 & OH 161 jct., Worthington, 25 Apr 1988, *Hoffman 36* (OS). FULTON CO. [2]: limy gravel, SE corner of Forrester Dr. & OH 2, Swanton, SE 1/4, Sec. 12 of T7N, R8E, 14 May 1988, *Rabeler 996* (MICH). HAMILTON CO.: flowerbed weed, Third & Elm sts., Cincinnati, 6 Apr 1988, *Cusick 27225* (MICH). KNOX CO.: near grain elevator and RR crossing, Mill St., NE of OH 95, Fredericktown, 2 Jun 1994, *Cusick 31701* (MICH, OS). LAWRENCE CO. [2]: sandy area, cemetery, Proctorville, 20 Apr 1980, *J. C. Bryant s.n.* (MU). LOGAN CO.: gravel parking lot, Fox Island picnic area, Indian Lake State Park, N of US 33, Stokes Twp., 1 May 1991, *Cusick 29457* (MICH, OS). MERCER CO.: gravel parking lot, St. Paul Church, McMillan & St. Anthony rds., W of Erastus, 1 May 1991, *Cusick 29460* (MU). MUSKINGUM CO.: trampled earth, Putnam Hill Park, E of Pine St., Zanesville, 15 May 1991, *Cusick 29525* (CM, MICH, OS). PAULDING CO.: limestone ballast, E side of Cleveland St. RR crossing, 1 block S of US 24 (W. River St.), Antwerp, SW 1/4, Sec. 27 of T3N, R1E, 14 May 1994, *Rabeler 1182* (MICH, UC). SCIOTO CO. [2]: parking lot cracks, S side of US 52, ca. 1.6 km W of OH 139, New Boston, 8 Apr 1989, *McCormac 268* (MICH). SUMMIT CO.: gravel roadbed, village park, Division St., Clinton, 18 May 1994, *Cusick 31652* (MICH). WARREN CO.: roadside, Oregonia, 27 Apr 1992, *Thieret 57288* (KNK). WILLIAMS CO.: limestone ballast, NW corner of Depot & Empire Sts., Montpelier, NW 1/4, Sec. 11 of T7N, R2E, 2 May 1992, *Rabeler 1132* (CLM, KE, MICH). WOOD CO.: along unused CSX RR track, S of W. 3rd St., W of Louisiana St., Perrysburg, 14 May 1988, *Rabeler 993* (MICH, OS).

WEST VIRGINIA. MASON CO.: Lone Oak Cemetery, E of WV 62, Point Pleasant, 21 Apr 1992, *Cusick 30136* (CM, MICH, WVA). OHIO CO.: roadside, 2.5 km E of Valley Grove, 24 Apr 1992, *Thompson 10043* (CM, MICH).

Swink and Wilhelm's (1994) mapping of *C. pumilum* in three northwestern Indiana counties, based in part on Rabeler's annotation of specimens at MOR, is the first for Indiana. The collections from 13 counties we cite below illustrate the presence of *C. pumilum* at scattered sites in northern, central, and extreme southern Indiana.

INDIANA. ALLEN CO.: curb edge, E side of Hartzell Rd., ca. 160 m N of US 24 (Lincoln Way), New Haven, NW 1/4, Sec. 11 of T30N, R13E, 14 May 1994, *Rabeler 1181* (IND, MICH). DEARBORN CO.: weedy lawn, edge of school building, E side of Lawrenceburg, 8 May 1994, *Thieret 57308a* (MICH). DE KALB CO.: limestone ballast along sidewalk, W side of IN 327 (N. Randolph St.), 30 m N of CSX RR crossing, Garrett, SW 1/4, Sec. 33 of T34N, R12E, 14 May 1994, *Rabeler 1179* (ISC, MICH, US). ELKHART CO.: lawn, opposite NW corner of RR depot, Tyler & S. 2nd Sts., E of IN 19 underpass, Elkhart, NE 1/4, Sec. 8 of T37N, R5E, 14 May 1994, *Rabeler 1171* (MICH, MOR). GIBSON CO.: roadside and mowed grassland, Gibson power plant, NE 1/4, Sec. 33 of T1S, R12W, 22 May 1978, *McClain 2385* (IND; coll. mixed with *C. glomeratum*). GRANT CO. [3]: old RR spur, Railroad St., W of Main, Upland, SE 1/4, NE 1/4, Sec. 10 of T23N, R9E, 5 May 1993, *Rothrock 2818* (IND, MICH). HANCOCK CO.: eastbound I-70 rest area, 5.6 km W of Co. Rd. 850E, 21 May 1989, *Vincent 4066* (MU). HENDRICKS CO.: parking lot edge, westbound I-70 rest area, 13 km E of Monrovia exit, 16 May 1993, *Rothrock 2862* (MICH). KOSCIUSKO CO.: along sidewalk, N side of 4th St., E of Conrail RR crossing, 3 blocks E of IN 15 (Higbee St.), Milford, SE 1/4, Sec. 9 of T34N, R6E, 14 May 1994, *Rabeler 1173* (MICH, ND). LAGRANGE CO.: gravel edge of parking area, West Lake Community Park, E side of Morrow St., 0.16 km S of IN 700S (Lake St.), Topeka, NE 1/4, Sec. 36 of T36N, R8E, 14 May 1994, *Rabeler 1175* (IND, MICH). NOBLE CO.: limestone ballast along sidewalk, Conrail RR crossing, W. Rush St., 0.4 km W of S. Main St., Kendallville, SW 1/4, Sec. 33 of T35N, R11E, 14 May 1994, *Rabeler 1178* (MICH). STEUBEN CO.: W side of blacktop parking lot, W of W building, Redwood Motel, US 20, 2.7 km E of US 20–I-69 jct., Angola, center, Sec. 27 of T37N, R13E, 27 Jun 1992, *Rabeler 1135* (BUT, MICH). WHITLEY CO.: sandy parking lot edge, Churubusco High School, N of end of W. Tulley, 2 blocks W of US 33, Churubusco, NW 1/4, Sec. 11 of T30N, R13E, 14 May 1994, *Rabeler 1180* (MICH, RSA).

Browne and Athey (1992) listed *C. pumilum* from the Coastal Plain Province in extreme western Kentucky, possibly on the basis of a specimen at MEM which we have not seen. Recent collections made from northern and west central Kentucky both extend the range and confirm its presence in the state.

KENTUCKY. CARROLL CO.: along railroad, Carrollton, 25 Apr 1994, *Thieret 57314* (KNK, MICH). GREENUP CO.: picnic area along Ohio River, Greenup Locks, E of KY 3116, N of Lloyd, 20 Apr 1992, *Cusick 30128* (MICH; CM and a second MICH sheet are *C. glomeratum*). TRIMBLE CO.: 50-cm-wide area, I-71 roadside, 13 km E of Bedford, 26 Apr 1994, *Thieret 57200* (KNK, MICH). WARREN CO.: brick sidewalks, Fountain Park, E. Main St., Bowling Green, 7 Apr 1994, *Cusick 31520* (MICH).

Rabeler (1988a) reported *Cerastium pumilum* from three Michigan counties. Four additional counties can now be added, all in the southern portion of the state.

MICHIGAN. BRANCH CO.: along sidewalk at RR crossing, W side of Church St., 0.25 km N of US 12, Quincy, SW 1/4, Sec. 15 of T6S, R5W, 14 May 1994, *Rabeler 1163* (MICH, MSC). CALHOUN CO.: vacant lot, SE corner of M-60/M-99 (Leigh St.) & Sophia St., 1 block E of M-60 & M-99 jct., Homer, NW 1/4, Sec. 8 of T4S, R4W, 20 Jun 1993, *Rabeler 1142B* (MICH). JACKSON CO.: grassy area between S side of E. Michigan Ave. and N parking lot edge, E of E entrance to Meijer, Jackson, NW 1/4, Sec. 31 of T2S, R1E, 26 May 1991, *Rabeler 1129* (MICH, MIN, OSH, RM). LIVINGSTON CO.: 10 m W of former RR depot, 50 m W of Hwy D-19, 0.5 km N of M-36 & D-19 jct., Pinckney, NW 1/4, Sec. 23 of T1N, R4E, 19 Jun 1993, *Rabeler 1140* (MICH, NY).

Cerastium semidecandrum L.

Cerastium semidecandrum can be added to the floras of Kentucky and Ohio. Although new to the Ohio flora, the appearance of *C. semidecandrum* is not surprising considering its presence in all neighboring states [Indiana (Crovello et al. 1983, Swink & Wilhelm 1994), Kentucky (reported here), Michigan (Voss 1985), Pennsylvania (Rhoads & Klein 1993), and West Virginia (Duppstadt 1987)] and preference for disturbed areas. We believe that the apparent limitation to northern Ohio is an artifact of our collecting; two of the Kentucky collections are from counties just across the Ohio River from the Cincinnati area.

KENTUCKY. CAMPBELL CO.: roadside, 2.5 km S of Wilder, 20 May 1984, *Thieret 55060* (KNK). KENTON CO.: roadside, Taylor Mill, 31 May 1984, *Thieret 55061* (KNK). MARTIN CO.: roadside, just SW of Inez, 3 May 1992, *Thieret 55782* (KNK).

OHIO. ASHTABULA CO. [2]: sandy roadside, Lakeview Park, N of Lake Rd., Conneaut, 4 May 1993, *Cusick 30774* (MICH, OS). CUYAHOGA CO. [2]: parking lot, Lakefront State Park boat launch, N of I-90, NW of Liberty Blvd., Cleveland, 7 May 1993, *Cusick 30819* (MICH). FULTON CO. [3]: limy gravel, SE corner of Forrester Dr. & OH 2, Swanton, SE 1/4, Sec. 12 of T7N, R8E, 14 May 1988, *Rabeler 996A* (MICH). LAKE CO. [3]: sandy lawn, 5662 N Ridge W (US 20), 0.6 km E of US 20 & McMackin Rd. jct., Madison Twp., T12N, R6W, 23 Jun 1990, *Rabeler 1106* (CLM, MICH). LUCAS CO. [5]: roadside, OH 64—Jeffers Rd. jct., NW of Whitehouse, Swanton Twp., 10 May 1988, *Cusick 27324* (MICH, [NY], OS). WOOD CO.: Graham Cemetery, S of Graham Rd., 0.8 km E of Wayne Rd., S of Wayne, 17 May 1990, *Cusick 28835* (MICH, [NY], OS).

Although known in Indiana since at least 1948 (LaPorte Co., *F. A. Swink s. n.* (MOR)), the only specimens of *C. semidecandrum* that we had seen prior to 1994 were all from counties included within the range of *Plants of the Chicago Region* (Swink & Wilhelm 1994). The specimens cited below illustrate that it is also known in northern and extreme southern Indiana.

INDIANA. DEARBORN CO.: weedy lawn, edge of school building, E side of Lawrenceburg, 8 May 1994, *Thieret 57308b* (MICH). ELKHART CO. [2]: lawn, opposite NW corner of RR depot, Tyler & S. 2nd Sts., E of IN 19 underpass, Elkhart, NE 1/4, Sec. 8 of T37N, R5E, 14 May 1994, *Rabeler 1172* (MICH). LAGRANGE CO.: gravel parking lot edge, near corner of Meyers and 1st Sts., 1 block E of jct. of Meyers St. & IN 5 (Main St.), Wolcottville, SE 1/4, Sec. 33 of T36N, R10E, 14 May 1994, *Rabeler 1176* (IND, MICH). NOBLE CO.: limestone ballast along sidewalk, Conrail RR crossing, W. Rush St., 0.4 km W of S. Main St., Kendallville, SW 1/4, Sec. 33 of T35N, R11E, 14 May 1994, *Rabeler 1177* (MICH).

Voss (1985) mapped *Cerastium semidecandrum* from six Michigan counties, with Hazlett (1992) and Fritsch (1994) adding two additional counties, Leelanau and Hillsdale respectively. Twenty-one additional counties can now be added based on post-1985 collections, suggesting that this species is widespread, although often overlooked, in Michigan.

MICHIGAN. BARRY CO.: brick sidewalk, W end of former RR depot, E of W. Apple St. & N. Broadway jct., 1 block N of M-43 & M-37 jct., Hastings, NW 1/4, Sec. 17 of T3N, R8W, 29 May 1994, *Rabeler 1193* (MICH, UC). BAY CO.: lawns, Pinconning State Park, Sec. 19 of T17N, R5E, 9 May 1985, *Freudenstein 1536* (MICH). BRANCH CO.: sidewalk crack, S side of US 12 (E. Chicago St.), 100 m W of US 12 & S. Michigan Ave. jct., Coldwater, NE 1/4, Sec. 22 of T6S, R6W, 20 Jun 1993, *Rabeler 1143* (MICH). CALHOUN CO. [2]: sidewalk edge, W side of N. Clinton St., 10 m N of Conrail RR, 25 m N of W. Michigan St. & N. Clinton St. jct., Albion, SW 1/4, Sec. 35 of T2S, R4W, 20 Jun 1993, *Rabeler 1141* (MICH). CASS CO.: sandy roadside, S side of M-205, 0.15 km SW of US 12 & M-205 jct., SW 1/4, Sec. 16 of T8S, R14W, 14 May 1994, *Rabeler 1170* (MICH). CRAWFORD CO.: roadside, jack pine forest, SW side of Howes Lake, SE 1/4 of SW 1/4, Sec. 32 of T27N, R4W, 21 May 1992, *Chittenden 416 & Peil* (MICH). EATON CO.: limestone ballast, Grand Trunk RR siding, 3 m S of end of McClure St., 60 m W of M-50 (Cochran Ave.) jct., Charlotte, SE 1/4, Sec. 12 of T2N, R5W, 28 May 1994, *Rabeler 1184* (MICH, MSC). INGHAM CO. [2]: grassy median of circle drive to E. McDonel Hall, Michigan State Univ. campus, SE 1/4, Sec. 18 of T4N, R1W, 29 Apr 1985, *Rabeler 862* (MICH, MSC). IONIA CO.: sandy RR ballast, 5 m S of Central Michigan RR, 50 m E of Steele St. RR crossing, 1 block E of M-66 (Dexter St.), Ionia, NW 1/4, Sec. 19 of T7N, R6W, 28 May 1994, *Rabeler 1185* (BLH, MICH). JACKSON CO. [2]: sandy driveway edge at railroad tie fence, SW of RR depot, N side of E. Michigan Ave., Grass Lake, SE 1/4, Sec. 32 of T2S, R2E, 18 May 1991, *Rabeler 1126* (MICH, MIN). KALAMAZOO CO.: sidewalk cracks, edge of parking lot, northbound US 131 rest area, near Portage, SW 1/4, Sec. 30 of T3S, R11W, 23 Jun 1992, *Reznicek 9018 with Rothrock* (MICH, MSC). KENT CO.: sand under guardrail, SE corner of CSX RR crossing, S. Main St., Kent City, NW 1/4, Sec. 33 of T10N, R12W, 29 May 1994, *Rabeler 1188* (GH, MICH, US). LENAWEE CO.: lawn between sidewalk and curb, S side of W. Front St., 30 m E of N. Winter St., S M-52, Adrian, S 1/2, Sec. 35 of T6S, R3E, 14 May 1988, *Rabeler 986* (MICH, MSC, RM). MONROE CO. [2]: once-mowed field, N of sidewalk, N side of W. Elm Ave., 60 m W of CSX RR crossing, Monroe, 14 May 1988, *Rabeler 999* (MICH, WIS). MONTCALM CO.: sidewalk edge, N side of E. Fairbanks St. opp. S. Bracy Ave., 0.4 km E of M-91 (S. Lafayette St.), Greenville, NW 1/4, Sec. 16 of T9N, R8W, 28 May 1994, *Rabeler 1186* (ISC, MICH). MUSKEGON CO.: sidewalk edge, 10 m E of CSX RR crossing, Bailey Rd., 30 m W of M-37 (Newaygo Rd.), Bailey, SE 1/4, Sec. 2 of T10N, R13W, 29 May 1994, *Rabeler 1190* (MICH, RSA). NEWAYGO CO.: NW side of CSX RR crossing, Commerce St., W of M-37 (Maple St.), Grant, NW 1/4, Sec. 24 of T11N, R13W, 29 May 1994, *Rabeler 1191* (MICH, NY). OCEANA CO. [2]: sandy lawn near Longview Cottage, Camp Miniwanca, Benona Twp., Sec. 6 of T13N, R18W, 20 May 1991, *Rafaill 91-11* (gc). OTTAWA CO.: sidewalk edge, NE corner of Main & Watson Sts., 0.4 km W of Eastmanville Rd., Coopersville, SW 1/4, Sec. 23 of T8N, R14W, 29 May 1994, *Rabeler 1192* (HHH, MICH). ST. JOSEPH CO.: grass near road curb, SE corner of M-60 & M-66 jct. E of Mendon, NW 1/4, Sec. 30 of T5S, R9W, 14 May 1994, *Rabeler 1165* (MICH, USCH). WAYNE CO.: sidewalk edge, E side of Venoy Rd., S of Conrail RR crossing, 0.15 km S of Venoy Rd. & US 12 (Michigan Ave.) jct., Wayne, NW 1/4, Sec. 34 of T2S, R9E, 8 Jun 1994, *Rabeler 1195* (MICH).

HOLOSTEUM

Holosteum umbellatum L.

Voss (1985) mapped jagged chickweed from three Michigan counties; the following collections add three dots to that map.

MICHIGAN. CASS CO.: roadside, SE corner of M-60 & M-40 jct., Jones, SW 1/4, Sec. 35 of T6S, R13W, 14 May 1994, *Rabeler 1167* (BRIT, MICH). MONROE CO.: Erie-Union Cemetery, Cemetery Rd., 0.4 km N of Lakeside Rd., E of Samaria, Sec. 6 of T8S, R8E, 29 Apr 1991, *Cusick 29450* (CM, MICH). ST. JOSEPH CO.: grassy parking area, SE corner of St. Joseph Co. fairgrounds, Centreville, NE 1/4, Sec. 30 of T6S, R10W, 1 May 1994, *Rabeler 1161* (MICH, WIS).

Strausbaugh and Core (1978) cited *Holosteum umbellatum* collections from three West Virginia counties. The following collections are the first from the western half of the state; all but one of the other collections at WVA, including two not cited in Strausbaugh and Core (1978), are from the eastern panhandle region.

WEST VIRGINIA. CABELL CO.: gravel berm, 14th St. & Jefferson Ave., Huntington, 23 Mar 1994, *Cusick 31460* (MICH). MASON CO.: Lone Oak Cemetery, WV 2, Point Pleasant, 21 Apr 1992, *Cusick 30135* (CM, MICH, WVA). WAYNE CO.: picnic area below dam, East Lynn Lake, S of WV 37, East Lynn, 5 Apr 1993 Cusick 30696 (MICH).

MOEHRINGIA

Moehringia trinervia (L.) Clairv.

Moehringia trinervia, three-nerved sandwort, is a woodland herb found throughout much of Europe and in western Asia (Clapham et al. 1987, Halliday & Hind 1993). It bears a superficial resemblance to the ubiquitous *Stellaria media*; the specimen cited below was originally identified as *S. media*. *Moehringia trinervia* is distinguished from *S. media* by the following combination of characters: capsules shorter than sepals; sepals with very wide scarious margins; stems pubescent throughout, the hairs short and often curved downward; and shiny, black seeds that are smooth except for a white, lacerate appendage (strophiole) at the hilum (seed attachment scar). The last character is the primary feature used to distinguish *Moehringia* from *Arenaria*. Both European floras cited above mention that white, entire petals "1/2 to 2/3 as long as sepals" are present; these are not evident on the Ohio specimens examined here.

This appears to be the first report of this species in North America. The species is not mentioned in the *National List of Scientific Plant Names* (Rice et al. 1982), Gleason and Cronquist (1991), or Kartesz (1994). The Ohio population was found in a white pine-hemlock-northern hardwoods forest (*Pinus strobus* L., *Tsuga canadensis* (L.) Carrière, *Acer rubrum* L., and *Sassafras albidum* (Nutt.) Nees) on Little Mountain, an area that once was a thriving resort community (see Ahlstrom 1961, Cusick 1983); its appearance probably predates control of this property by the Holden Arboretum. The plant is abundant at this site (J. K. Bissell, pers. comm.), no doubt enhanced by the fact that *Moehringia trinervia* is both homogamous and self-compatible (Clapham et al. 1987).

OHIO. LAKE CO.: along trails in mixed hardwood forest, Little Mtn, Holden Arboretum, Concord Twp., 21 Jun 1990, *Bissell JKB:1990:149 & Danielson* (CLM, MICH).

PETRORHAGIA

Petrorhagia prolifera (L.) P. Ball & Heyw.

Rabeler (1980) reported childing pink as new to Michigan from sandy areas near Grand Haven (Ottawa Co.) and along a roadside about 19 km away in southern Muskegon County. The following collection extends the range northward by ca. 55 km.

MICHIGAN. OCEANA CO.: roadside, W side of Scenic Dr., Benona Twp., Sec. 5 of T13N, R18W, 29 Jun 1992, *Rafaill 92-57* (gc).

Petrorhagia saxifraga (L.) Link

Rabeler (1985) noted that saxifrage pink had been reported from Hocking County, Ohio (Cusick & Silberhorn 1977) but was not able to locate a specimen to verify the identification. Besides that specimen, three other collections from Ohio have now been found.

OHIO. ADAMS CO.: NW 1/4 of Sandy Springs Cemetery, US 52, Sandy Springs, 25 Sep 1980, *Cusick 20498* (OS). HOCKING CO.: Laurel Twp., 9 Jun 1930, *F. Bartley & L. L. Pontius s. n.* (OS). LAKE CO.: Perry, 1 Sep 1944, *F. J. Tyler s. n.* (OS). WOOD CO.: weedy edges, Fish Cemetery, Zepernick Rd., 0.8 km N of N. River Rd., New Rochester, 21 Jul 1992, *Cusick 30434* ([CM], MICH, [OS]).

STELLARIA

Stellaria alsine Grimm

Stellaria alsine (bog stitchwort) is a plant of wet areas. We agree with Gleason and Cronquist's (1991) statement about its status in North America: "widespread in Eurasia and perhaps only intr. with us, but appearing native." The North American distribution is primarily coastal; Newfoundland and Quebec south to Maryland and West Virginia (Gleason & Cronquist 1991), North Carolina (Radford et al. 1968), Tennessee (Wofford 1980), a single site each in Florida, Georgia, and Louisiana (Rabeler & Thieret 1988), Washington and Oregon ("as a lawn weed w. of the Cascades;" Hitchcock & Cronquist 1964), and British Columbia (Douglas 1989). Ownbey and Morley (1991) mapped S. alsine from two southern Minnesota counties. The report of *S. alsine* from Churchill, Manitoba is based on a misidentified specimen of *S. crassifolia* Ehrh. (Scoggan 1978).

The collection of *Stellaria alsine* we report is from far northeastern Ohio about 5 km W of the Pennsylvania line. Although most Pennsylvania collections of *S. alsine* are from the eastern part of the state (Rhoads & Klein 1993), it is known from northwestern Pennsylvania 110–160 km east of the Ohio site, including extreme southeastern Venango Co. (near Emlenton, *W. E. Buker s.n.*, 30 May 1978, CM), Elk Co. (near Hallton, *Grisez 285*, 17 May 1968, RM), and McKean Co. (S of Lewis Run, *W. E. Buker s.n.*, 8 Jun

1963, CM); we have not seen the specimen(s) from Warren County mapped in Rhoads and Klein (1993), a site about 120 km east of the Ohio site.

Stellaria alsine is most easily distinguished from *Stellaria longifolia* Muhl. ex Willd., a native species often found in wet areas, by inflorescence, floral, and seed features. While both species have axillary inflorescences, that of *S. alsine* is small (never appearing terminal) and few-flowered, each flower subtended by tiny, scarious bracts. The petals are shorter than the sepals (see Rabeler & Thieret (1988) for a single exception), narrow and deeply bifid, or absent. In contrast to the smooth seeds of *S. longifolia*, those of *S. alsine* are roughened.

OHIO. ASHTABULA CO.: Farnham, 4 Sep 1931, *Hicks 1004* (OS).

Stellaria pallida (Dumort.) Junger[1]

In his report of *Stellaria pallida* (lesser chickweed) as new to Michigan, Rabeler (1988a) also noted that it was known from North Carolina (Morton 1972) and reported from Pennsylvania by Wilkens (1975), a report that he has not yet confirmed. Thomas et al. (1991) noted that *S. pallida* is also known from nine Arkansas counties. The collections cited below document its occurrence in three additional states (Kentucky, Ohio, and West Virginia), the number of records in the Kentucky (14 counties) and Ohio (15 counties) suggesting that *S. pallida*, like the *Cerastium* species noted earlier, may be widely distributed, albeit often overlooked.

As noted by Rabeler (1988a) and earlier by Morton (1972), the most consistent features distinguishing *S. pallida* from *S. media* are the seed color (yellowish-brown vs. dark brown), size ($<$0.8 mm vs. $>$0.9 mm), and surface (acute vs. wavy, blunt papillae). Unfortunately, many of these specimens lack the red band at the base of the calyx which, as Rabeler (1988a) noted, permits a more direct recognition of *S. pallida*.

KENTUCKY. BOONE CO.: picnic area, I-75 rest area, N of I-75 & I-71 jct., S of Cincinnati, 1 Jun 1975, *Morton NA7797 & Venn* (jkm). BOYD CO. [2]: lawn, Ross Chapel, KY 773 & KY 1945 jct., Mayhew, 5 Apr 1990, *Cusick 28711* (MICH). CAMPBELL CO.: gravelly soil, Silver Grove railroad yard, 13 Apr 1986, *Thieret 56270* (KNK,

[1]Although Piré is usually credited with making the combination *Stellaria pallida*, his combination, as Chapman (1991) correctly noted, is invalidly published. Use of Piré's combination is counter to Art. 34.1(a) of the *International Code of Botanical Nomenclature* (Greuter et al. 1988) because Piré (1863) accepted Dumortier's placement of *Stellaria pallida* in *Alsine* and proposed the combination within *Stellaria* conditionally; *if* it was found that the genus *Alsine* should be included in *Stellaria*, the correct name *would* be *Stellaria pallida*. The combination cited in *Index Kewensis* (Jackson, 1895) for *Stellaria pallida* is also invalid; Nyman (1878–1882; *Stellaria*, p. 111, published in 1878 fide Stafleu & Cowan 1981) made the combination in synonymy, counter to Art. 34.1(c).

The next use of *Stellaria pallida* after 1863 that we are aware of is by Junger (in Uechtritz 1878) who accepted *S. pallida* and described *S. pallida* forma *brachypetala* (Boreau) Junger. This use now becomes the citation for the combination, Junger's citation of Piré being corrected as a bibliographic error (Art. 33.2).

MICH, NCU, VDB). ELLIOTT CO.: gravel roadway, Little Fork Church, KY 486, 0.5 km S of KY 486 & KY 863 jct., Dobbins, 16 Apr 1992, *Cusick 30113* (CM, MICH). FLOYD CO. [2]: trampled ground, picnic area below Dewey Dam, KY 3, N of Jenny Wiley State Park, NE of Prestonburg, 7 Apr 1992, *Cusick 30081* (MICH, MU). GRAYSON CO.: gravel berm, US 62, Leitchfield, 3 Apr 1994, *Cusick 31466* (MICH). GREENUP CO.: weedy ground, Bethlehem Church, US 23, 1/2 mi S of Edgington, 5 Apr 1990, *Cusick 28705* (MU; mixed with *S. media*). KNOTT CO.: picnic area, KY 160, at bridge over Carr Fork Lake, S of Littcar, 6 Apr 1993, *Cusick 30700* (MICH). LAWRENCE CO.: sidewalk edge, Madison St., Louisa, 16 Apr 1991, *Cusick 29371* (CM, MICH, MU). LEWIS CO.: gravel driveway, Union Church, KY 344 & Long Branch Rd., SW of Stricklett, 12 Apr 1988, *Cusick 27238* (MICH). MASON CO.: alleys near post office, Washington, 13 Apr 1989, *Cusick 27956 & Baird* (MICH, [NCU]). OHIO CO.: picnic area, Western Kentucky Parkway service plaza, 1.6 km NE of US 231 exit, SE of Beaver Dam, 3 Apr 1994, *Cusick 31465* (MICH). PERRY CO. [2]: weedy ground, Buckhorn Lake State Park lodge, KY 1833, SE of Buckhorn, 9 Apr 1993, *Cusick 30721* (CM, MICH). TRIGG CO. [2]: gravel parking lot, Cave Spring Church, N of KY 124, Cerulean, 4 Apr 1994, *Cusick 31477* (CM, MICH).

OHIO. ADAMS CO. [2]: Drake Cemetery, Twp. Rt. 416, 0.65 km SE of Co. Rt. 18, S of Blue Creek, 15 Apr 1978, *Cusick 18036* (OS). ALLEN CO.: gravel parking lot, Faurot Park, E of OH 117, Lima, 23 Apr 1991, *Cusick 29430* (MICH). ASHTABULA CO.: sandy soil, Walnut Beach Park, N of Walnut Blvd., Ashtabula, 4 May 1993, *Cusick 30780* (CLM, MICH, OS). AUGLAIZE CO.: gravel parking lot, motel area, Bellefontaine St., W of I-75, Wapakoneta, 23 Apr 1991, *Cusick 29447* (MICH, [OS]). FRANKLIN CO.: compacted earth, parking lot traffic islands, Fountain Square, S of Morse Rd., Columbus, 15 Apr 1991, *Cusick 29370* (MICH). GALLIA CO.: trampled lawn, rest area, OH 7, 0.5 km E of Double Creek Rd., NE of Crown City, 6 Apr 1992, *Cusick 30064* (MICH, OS). HENRY CO.: lawn, city park, N side of Maumee River, end of E. Front St., Napoleon, 22 Apr 1994, *Cusick 31540* (MICH). LAWRENCE CO.: picnic area along Ohio River, foot of Center St., Ironton, 15 April 1993, *Cusick 30738* (OS). LUCAS CO. [2]: lawn, E of Gate G, Univ. of Toledo stadium, Toledo, Sec. 32 of R7E, T9S, 14 May 1988, *Rabeler 987* (MICH, MU, OS). MERCER CO.: flowerbeds, city park, Lake Shore Dr., E of US 127, Celina, 1 May 1991, *Cusick 29478* (MICH, OS). OTTAWA CO. [2]: parking lot at ferry dock, end of OH 163, Catawba Island, 2 May 1988, *Cusick 27302* (MICH). ROSS CO.: Springbank Cemetery, E of OH 104, 0.55 km N of Kellenberger Rd., S of Yellowbud, 9 Apr 1990, *Cusick 28719* (MICH, OS). SCIOTO CO. [2]: picnic area along Ohio River, Greenup Locks, US 52, NW of Franklin Furnace, Green Twp., 10 Apr 1991, *Cusick 29345 & Baird* (MICH). SUMMIT CO.: gravel roadbed, village park, Division St., Clinton, 26 Apr 1994, *Cusick 31555* (KE, MICH, OS). WOOD CO.: grass next to unused CSX RR track, S of W. 3rd St., W of Louisiana St., Perrysburg, 14 May 1988, *Rabeler 994* (MICH, OS).

WEST VIRGINIA. CABELL CO.: rest area, S side of I-64, 1.6 km W of WV 10 exit, S of Huntington, 16 Apr 1991, *Cusick 29388* (MICH; CM collection is *S. media*). WAYNE CO: picnic area, Beech Fork Lake State Park, S of Co. Rts. 43 & 17-8 jct., W of Winslow, 16 Apr 1991, *Cusick 29383* (CM, WVA [WVA label erroneously changed to read 29388]).

Swink and Wilhelm (1994) included *Stellaria pallida* in the latest edition of *Plants of the Chicago Region*, providing both the first report for Indiana (mapping it for four counties) and an additional Michigan county (Berrien; *Wilhelm 20248 with Reznicek*, MOR). The specimens cited below add four counties from northern, central, and extreme southern Indiana and a fourth Michigan county (Rabeler (1988a) had reported it from two counties).

INDIANA. GRANT CO. [2]: weedy area, NW door of Taylor Univ. Student Center, near parking lot, Upland, NE 1/4 of SW 1/4, Sec. 10 of T23N, R9E, 3 May 1993, *Rothrock 2766* (IND, MICH). KOSCIUSKO CO.: along fence and near stop sign, E side of Shaffer St., S of jct. with Syracuse Rd., Milford, SE 1/4, Sec. 9 of T34N, R6E, 14 May 1994, *Rabeler 1174* (MICH, ND, OSH, US, WIS). VERMILLION CO.: roadside and old fields, Cayuta [Power] Plant, Sec. 15 of T17N, R9W, 18 May 1978, *McClain 2300* (IND). WARRICK CO.: car park by road, Newburgh, 24 Apr 1972, *Morton NA4495* (jkm).

MICHIGAN. ST. JOSEPH CO.: grass near road curb, SE corner of M-60 & M-66 jct. E of Mendon, NW 1/4, Sec. 30 of T5S, R9W, 14 May 1994, *Rabeler 1164* (MICH).

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ANNOUNCEMENT: MICHIGAN FLORA

MICHIGAN FLORA, Part 3, is nearing completion. It will include the remaining families of dicots, approximately 775 species in families Ericaceae (Pyrolaceae) through Compositae—exactly the same families as in vol. 3 of Gleason's *New Britton and Brown Illustrated Flora.* Examination of specimens in herbaria other than the University of Michigan is well under way and should be completed in the fall of 1995, when distribution maps and arrangements for illustrations will also be undertaken.

Persons with institutional or private herbaria under their care and which contain Michigan specimens that might add important distribution records are encouraged (if not already in contract) to notify Edward G. Voss, Herbarium, North University Bldg., University of Michigan, Ann Arbor, Michigan 48109-1057. Labeled collections made during the 1995 field season can add counties to the maps if they are available by the end of the year. (As in the first two parts of the Flora, distribution maps will be based only on specimens examined.)

AMERICAN CHESTNUT INFECTED WITH HYPOVIRULENT BLIGHT AT ARNER POINT, ONTARIO

Brendon M. H. Larson
4747 4th Concession, R.R.2
Harrow, Ontario
N0R 1G0

Gerald Waldron
7641 King's Highway 18
R.R.1
Amherstburg, Ontario
N9V 2Y7

Plant communities containing American chestnut, *Castanea dentata* (Marsh.) Borkh., have become increasingly uncommon in southern Ontario as a result of deforestation and chestnut blight, *Cryphonectria parasitica*. As in other parts of the chestnut's range, the Ontario trees were declared doomed by mid-century (Fox 1949). Before the blight struck in the 1920's, the Ontario chestnut population was 300,000–400,000 (McKeen & Ambrose 1988). In contrast, the most recent survey (Ambrose & Aboud 1986) located only 82 trees over 10 cm dbh (diameter at breast height) growing in just 49 natural sites. On this basis the tree was given threatened status in Canada. It is very rare in Essex County, Ontario, near the northwestern edge of its range (Ambrose & Aboud 1986).

Longtime residents remember when chestnut trees could be readily found in the Cedar Creek area of Essex County (W. Balkwill, pers. comm.). Today, even stump sprouts are difficult to find. However, the largest American chestnut in the Canadian portion of the original range is found at Arner Point along Cedar Creek (J. Ambrose, pers. comm.). In addition, Arner Point chestnuts exhibit infection by hypovirulent blight. Unlike most Michigan trees with hypovirulent blight, these trees are within the native range of the species (Brewer 1982). Since the potential for biological control of chestnut blight by hypovirulent strains has been demonstrated (Choi & Nuss 1992), the Arner trees are of some importance.

The purposes of this study were: i) to provide baseline data on the composition of a community containing chestnut infected with hypovirulent blight, and ii) to detail the recent history of the chestnut population and discuss its present status and importance as a source of hypovirulent blight.

DESCRIPTION OF STUDY SITE

Arner Point is located on lot 28, Front Concession, Gosfield South Township, Essex County (14°01′N, 82°01′W). It is a forested triangle of about five hectares, bounded by branches of Cedar Creek on two sides and agricultural land on the other (Figure 1). The site is an Essex Region Conservation Area, an Environmentally Significant Area (Oldham 1983), and part of the Ontario Ministry of Natural Resources' Cedar Creek Area of Natural and Scientific Interest (ANSI) (Allen & Oldham 1989). This forest

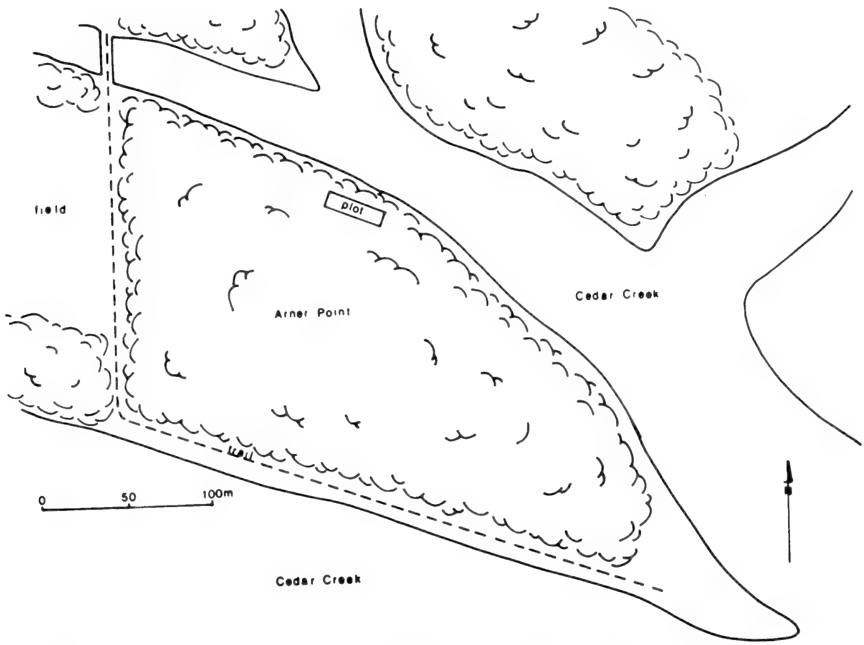

FIGURE 1. Location of the plot on Arner Point in Essex County, Ontario.

is included in the Niagara Section of the Deciduous Forest Region by Rowe (1977), but in Ontario it is more commonly referred to as the Carolinian Zone (Thaler & Plowright 1973). It is one of the 49 sites still supporting American chestnut in Ontario (Ambrose & Aboud 1986). The soils are of the Fox Sandy Loam series, which are well drained and moderately acidic. Elevation is 177 m, with little relief, and annual precipitation averages 737 mm.

Trees were cut on Arner Point from 1833 to the 1940's. Many oaks and maples were cut (A. Arner, pers. comm.), and their stumps can still be found. An aerial photo taken in May, 1947 shows a much more open canopy than at present. The presence of Scots pine (*Pinus sylvestris* L.) and red cedar (*Juniperus virginiana* L.) confirms the disturbed nature of the area. Cores taken from the pines indicate a planting date around 1940.

METHODS

A 10 m × 35 m plot was located about midway along Arner Point and 10 m from the north shore (Figure 1). It was chosen to represent the community associated with the large chestnut tree. In September and October 1987, all woody plants in the plot were identified, mapped, and their diameter at breast height (dbh) recorded. Because the species were identified in the fall and were often only seedlings, cherries, ashes, and elms were recorded as *Prunus* spp., *Fraxinus* spp., and *Ulmus* spp., respectively. Individuals of each species were organized into seven size classes. The total number of trees of each species was divided by the total number of all trees to determine values of relative density. The total basal area of each species was divided by the combined basal area of all species to determine values of relative basal area. An importance value was determined by averaging the relative density and relative basal area of each species.

The plot was permanently marked at the corners with steel posts, and copies of the plot survey have been deposited with the Essex Region Conservation Authority, Essex, Ontario.

RESULTS AND DISCUSSION

I. Baseline Community Data

The density of woody plants in the plot was about 11,500 plants per hectare (Table 1). The overstory species were sassafras (*Sassafras albidum* (Nutt.) Nees), shagbark hickory (*Carya ovata* (Mill.) K. Koch), red oak (*Quercus rubra* L.), white oak (*Q. alba* L.), and chestnut. Only sassafras was well represented in all size classes but many of these may have been suckers rather than seedlings (Table 2). Sugar maple (*Acer saccharum* Marsh.) was absent from the plot although it is a dominant in nearby woodlots. Beech (*Fagus grandifolia* Ehrh.), its usual codominant, was present. This supports the observation that past disturbance has been great. Much of the valuable maple may have been removed by logging, but the absence of all age classes indicates a period of intense browsing as well. Beech may have been left because of its inferior lumber, which would account for the large trees remaining.

The species with the largest number of seedlings and saplings in the plot were cherries, bitternut hickory (*Carya cordiformis* (Wang.) K. Koch.), blue beech (*Carpinus caroliniana* Walt.), red maple (*Acer rubrum* L.), ash, elm, and black oak (*Quercus velutina* Lam.). It is likely that there will be some recruitment of these species (except for blue beech which is an understory species) into the overstory. Beech can be expected to increase, owing to its ability to reproduce under closed canopies (Fowells 1965). This increase in canopy cover may have important consequences for chestnut at Arner Point, as the species is shade-intolerant (Barnes & Wagner 1981).

II. Chestnut at Arner Point

The chestnut tree in the plot began as a stump sprout; in 1988 it was possible to count 33 growth rings on the adjoining stump. At present (1993) the tree is 24 m tall with a 73.5 cm dbh. Although blight-infected, it shows only the superficial cankers associated with hypovirulent strains of blight

TABLE 1: Density per hectare (D), relative density as a percent (RD), basal area in m^2 (B), relative basal area as a percent (RB), and importance value (I) of tree species in the plot at Arner Point, Ontario.

Species	D	RD	B	RB	I
Castanea dentata (Marsh.) Borkh.	85.7	0.7	10.99	30.6	15.6
Prunus spp.	3285.7	28.5	0.41	1.1	14.9
Sassafras albidum (Nutt.) Nees.	1085.7	9.4	6.47	18.0	13.7
Carpinus caroliniana Walt.	1628.6	14.1	3.62	10.0	12.0
Quercus alba L.	28.6	0.2	8.07	22.4	11.3
Carya cordiformis (Wang.) K. Koch.	1942.9	16.8	0.72	2.0	9.4
Acer rubrum L.	1485.7	12.9	0.13	0.4	6.7
Fraxinus spp.	714.3	6.2	0.42	1.2	3.7
Quercus rubra L.	28.6	0.2	1.76	4.9	2.6
Carya ovata (Mill.) K. Koch.	28.6	0.2	1.29	3.6	1.9
Ulmus spp.	400.0	3.5	0.03	0.1	1.8
Ostrya virginiana (Mill.) K. Koch.	57.1	0.5	0.51	1.4	1.0
Lindera benzoin (L.) Blume	314.4	2.7	0.04	0.1	1.4
Quercus velutina Lam.	257.1	2.2	0.23	0.6	1.4
Cornus florida L.	57.1	0.5	0.75	2.1	1.3
Amelanchier arborea (Michx. f.) Fern.	28.6	0.2	0.50	1.4	1.3
Fagus grandifolia Ehrh.	57.1	0.5	0.02	0.1	0.3
Crataegus spp.	57.1	0.5	0.00	0.0	0.3
TOTALS	11542.8	99.8	35.96	100.%	100.6

(Hartline 1980). In the past decade, a large open canker has closed and the tree presents a nearly perfect picture of health.

Three smaller chestnut trees are found nearby. One is a vigorous 2-m sapling and another a cluster of stump sprouts. The sprouts, although blight-infected, appear to have healing cankers. The third tree unfortunately died after falling into Cedar Creek as a result of the erosion associated with recent high water levels. Sections taken from the trunk of this dead tree have proven interesting (Figure 2). The tree was at least 36 years old when it died in 1983, which dates its establishment to before 1947. A large blight canker appeared 18 years later and expanded for the next five years until 1970. Then the tree began to overgrow the canker. We can thus date the appearance of hypovirulent blight on this tree to 1970.

The dead tree likely allowed cross-pollination of the large tree in the plot. As a result, nut production by the large chestnut in the plot has been scanty

TABLE 2: Size class distribution (dbh in cm.) of woody plants in the plot at Arner Point, Ontario.

Species	Number of Individuals							
	dbh = <2	2–4.9	5–9.9	10–14.9	15–19.9	20–24.9	>25	TOTAL
Prunus spp.	113		2					115
Carya cordiformis	67				1			68
Carpinus caroliniana	19	21	10	6	1			57
Acer rubrum	51	1						52
Sassafras albidum	24	1	1	8	2	1	1	38
Fraxinus spp.	22	1	1	1				25
Ulmus spp.	14							14
Lindera benzoin	10	1						11
Quercus velutina	6		3					9
Castanea dentata	2						1	3
Cornus florida		1			1			2
Crataegus spp.	2							2
Fagus grandifolia	1	1						2
Juniperus virginiana			2					2
Ostrya virginiana	1				1			2
Amelanchier arborea					1			1
Carya ovata						1		1
Quercus alba							1	1
Quercus rubra							1	1

since the other tree died in 1983. Of 539 burrs collected in 1988, only three contained what appeared to be viable seed. Furthermore, seedlings are destroyed and suppressed by deer and rodent browsing; for example the 2-m sapling in the plot was browsed down to one meter over the winters of 1988–1989, 1989–1990, and 1990–1991. Four seedlings documented in 1983 had disappeared by 1988, including one in the plot. At present there are no known seedlings outside of the plot. This is unfortunate now that blight hypovirulence is giving some hope for a recovery of the species.

Further closure of the tree canopy at Arner Point will create further difficulties for seedling establishment. Conservation management by the Essex Region Conservation Authority will need to address these problems.

The chestnut trees at Arner Point host two strains of hypovirulent blight (C. McKeen, pers. comm.). These strains have been cultured and studied by members of the Canadian Chestnut Council. Cultures of the two strains have been used to innoculate blight-infected chestnuts in other parts of the Canadian range of the species, with encouraging results. Owing to a vegetative incompatibility system operating in *Cryphonectria parasitica*, only compatible strains will accept the double-stranded RNA responsible for hypovirulence (Choi & Nuss 1992). It is likely that the strains in a given locality exhibit this compatibility to a greater degree than they would with strains from distant areas. Thus, the Arner Point chestnuts assume a regional significance in maintaining the hypovirulent strains most likely to transmit hypovirulence to other strains of blight in the Essex region.

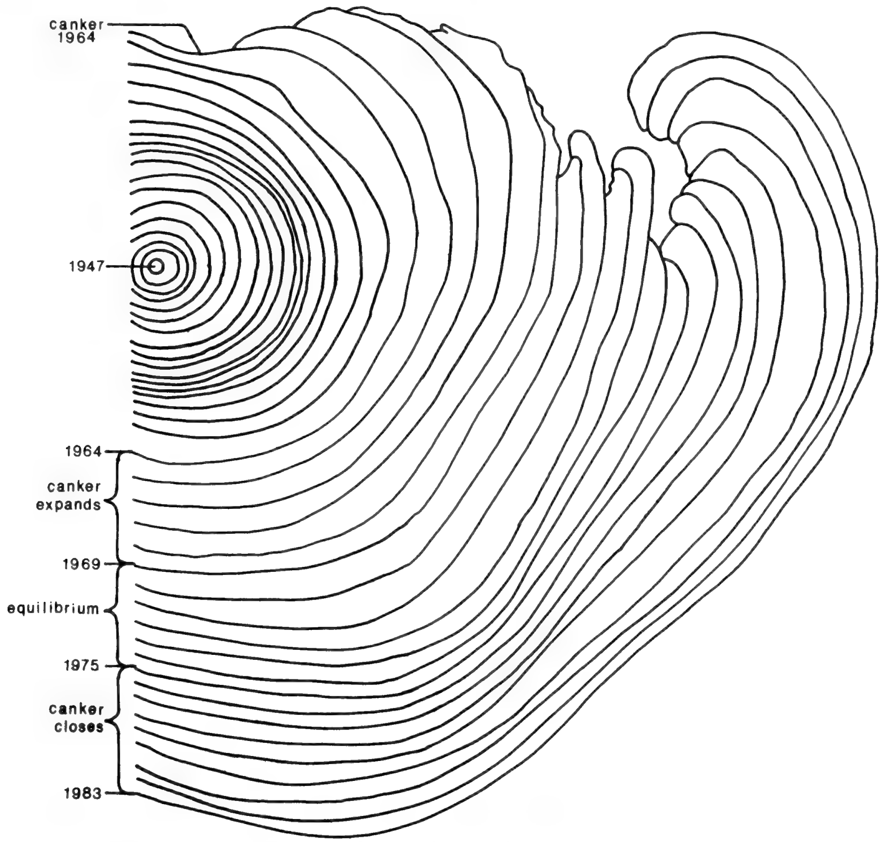

FIGURE 2. Cross-section of trunk of dead American chestnut tree at Arner Point, Ontario.

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REVIEW

THE ELFIN WORLD OF MOSSES AND LIVERWORTS OF MICHIGAN'S UPPER PENINSULA AND ISLE ROYALE. Janice M. Glime. Isle Royale Natural History Association, Houghton, Michigan. 1993. iv + 148 pages. [ISBN 0-935289-04-6.] Price $20.59 US (includes tax and shipping). [Available from: Isle Royale Natural History Association, Isle Royale National Park, Houghton, Michigan, 49931, USA.]

This excellent field guide is presented in a 5 1/2 × 8 1/2″ format so it can be easily carried by ". . . those who walk the many trails of the Upper Peninsula, Isle Royale and elsewhere in the Upper Great Lakes, who have an interest in the plants around them, but have no training in the identification of mosses or their relatives, the liverworts." An outstanding feature of the book is the inclusion of 175 superb color photographs illustrating the environments in which mosses and liverworts grow and the most likely species found in each. The beginner will find these photographs very useful in recognizing particular kinds of mosses and liverworts, and the professional bryologist will enjoy seeing many "old friends" portrayed so splendidly.

After an introduction to the features and life cycles of bryophytes and "moss neighbors" (lichens), the book is organized around types of environments with attention given to bogs and fens, marshland, cedar swamps, streams and lakes, stream banks, dung, deciduous forests, tree bases, tree trunks, logs and stumps, exposed soil of uprooted trees, jack pine and boreal forests, fire sites, shaded rocks, exposed rocks and sand, lakeshore rocks, paths, and dry or disturbed soil. Each environmental section begins with a brief description of the environment followed by treatments of the mosses and liverworts most likely to be found there. The section on bogs and fens, for instance, displays ten species of *Sphagnum* along with species of *Aulacomnium, Tomenthypnum, Drepanocladus,* and *Scorpidium.* The section on streams and lakes includes treatments of *Bryum, Chiloscyphus, Fissidens, Fontinalis, Hygrohypnum, Hygroamblystegium, Leptodictyum, Platyhypnidium,* and *Riccia.* The treatments of individual species begin with the name of the moss or liverwort, a guide to pronunciation, and its common name, e.g. *Fontinalis novae-angliae* (Fon′ tin al′ iss noh vee ang′ lee ia)—New England Brook Moss. A superscript following the technical name indicates whether the moss or liverwort has been found at Isle Royale or Pictured Rocks, a favorite place on the Lake Superior shoreline frequented by visitors to Michigan's Upper Peninsula.

The color photographs are high quality close-ups showing the features of the species and its particular environment. Many of them are so good that field identification is easily accomplished, in many cases without even the aid of a hand lens. Recognition of the 148 species included in "The Elfin World . . ." will take one quite far into the wonders of this miniature realm.

The book contains much of human interest as well. Among other things, Janice Glime observes that, "After a few years of berry pickers making a path across the (*Sphagnum*) mat, the path becomes a water trail" (p. 21), "George Washington reputedly fed rock tripe (*Umbilicaria*) to his troops in a broth of water . . . but there seems to be no documentation that such an event ever actually took place" (p. 18), "If you rest on a hummock of sedges, you might encounter branches of miniature scythe or sickle blades, all pointed in a single direction as if neatly hung up for the season. These blades most likely are the long curved leaves of *Drepanocladus*." (p. 33), and so on throughout the book. These observations make the book fun to read as well as useful in the field.

This book is highly recommended for beginner and professional alike. All will find it useful, informative, and, at times, entertaining. The high quality of the photographs and its low price insures that it will be a pleasant companion while exploring "The Elfin World . . ."

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ORNITHOGALUM UMBELLATUM L. (LILIACEAE), AN INVASIVE PERENNIAL IN THE WRIGHT STATE UNIVERSITY WOODS (GREENE COUNTY, OHIO)

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ABSTRACT

Several invasive properties of an *Ornithogalum umbellatum* L. (Liliaceae) population were investigated in a southwestern Ohio forest. From 1987 to 1993, the presence of *O. umbellatum* in 1 m^2 plots increased from 7% to 16% in an older growth portion of the forest and decreased from 23% to 8% in a 40-year-old stand. In 1994 stem density averaged 35.1/m^2 in the older growth site and 3.1/m^2 in the 40 year old stand. Vegetative reproduction was greatest in the older site. In 1994 an average of 14.3 bulbs per stem was observed in the older stand compared with 7.7 in the younger stand. *Ornithogalum umbellatum* dispersing fronts moved an average of 7.8, 6.0, and 12.4 cm in 1992, 1993, and 1994, respectively. Detrended correspondence analysis ordinated plots containing an *O. umbellatum* relative frequency (RF) > 25% from those with RF < 25%. All plots with a RF > 25% were located under canopy gaps or in disturbed soils, suggesting that *O. umbellatum* specializes in moderately disturbed sites.

INTRODUCTION

Ornithogalum umbellatum L. (Liliacaeae), commonly known as Star-of-Bethlehem, is a naturalized species introduced from Europe during the previous century (Braun 1967). Originally used as an ornamental, it rapidly escaped into several habitat types. In the United States *O. umbellatum* can be found commonly in cultivation, along roadsides, in fields, and in moist, open woodlands.

Naturalized populations of *O. umbellatum* are known to occur in 35 states and the District of Columbia. Duncan and Foote (1975) reported it from Alabama, Mississippi, and Nebraska. It has bee reported from Arkansas (Smith 1978), Connecticut, Maine, Massachusetts, Rhode Island, and Vermont (Seymour 1969), Delaware (Tatnall 1946), the District of Columbia (Ward 1881), Georgia (Duncan & Kartesz 1981), Illinois (Jones & Fuller 1955), Indiana (Deam 1940), Iowa (personal communication, Deb Lewis, Iowa State University), Kansas (Barkley 1968), Kentucky (Wharton & Barbour 1974), Louisiana (Thomas & Allen 1984), Maryland (Shreve 1909), Michigan (Voss 1972), Minnesota (Ownbey & Morley 1991), Missouri (Steyermark 1940), New Hampshire (Britton 1907), New Jersey (Britton 1889), New York (Zenkert 1934), North Carolina and South Carolina (Radford et al. 1968), Ohio (Braun 1967), Oklahoma (Waterfall 1979), Pennsylvania (Porter 1903), South Dakota (Van Bruggen 1985), Tennessee (personal communication, Steve Baskauf, Vanderbilt University), Texas (Hatch et al. 1990), Utah (Welsh et al. 1987), Virginia (Harvill et al. 1977), and West Virginia (Core 1958). Naturalized *O. umbellatum* has not been reported from Arizona, California, Colorado, Florida, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Washington, Wisconsin, and Wyoming.

In Ohio and most of the middle and northeastern states, *O. umbellatum* commonly invades moist woodlands especially along streams and open trails. Many floras list this species as a troublesome weed or pest which is difficult to eradicate (e.g., Deam 1940, Braun 1967, Mohlenbrock 1970). Deam (1940) reported its presence in woodland patches covering an acre or more and noted that it can grow in high densities, causing the elimination of other vegetation. Mohlenbrock (1970) indicated that it occurs in nearly virgin forest in Illinois. Despite its ability to invade and thrive in many non-native habitats in the United States and elsewhere, the species is threatened in many regions of its native European range (Mezev-Krichfalushiy et al. 1989).

In woodlands the plant reproduces prolifically by asexual means and consequently may represent a potential threat to native vegetation. Sexual reproduction is less common in woodlands (pers. obs.). In Ohio, flowering occurs from late March through early May, and in woodlands this species functions as a spring ephemeral as all of its above-ground biomass senesces before full canopy leaf-out. Usually, up to 16 daughter bulbs are produced each season (pers. obs.). The bulbs are produced as the foliar tissue senesces in late spring. As the previous season's daughter bulbs leaf out in the spring, they are pushed upwardly and outwardly towards the surface of the soil by new roots and can move several centimeters through this process. Dispersal by humans and other animals may also occur (pers. obs.).

The purpose of this project was to investigate the rate at which *O. umbellatum* may spread within woodland habitat through asexual reproduction and to assess its possible impact on the native vegetation.

MATERIALS AND METHODS

Field observations were made in two stands in the Wright State University woods located in Bath Township, Greene Co., in southwestern Ohio (longitude 34°3′ W and latitude 39°45′ N). The stands sampled were an older growth area dominated by *Acer saccharum* L., *Quercus rubra* L., and *Quercus alba* L. and an approximately 45-year-old (determined from aerial photographs dating back to 1940) wooded area dominated primarily by *Acer saccharum* (DeMars and Runkle 1992). The older growth area represents the western, upland portion of a large older growth stand with an elevation of 280 to 282 m. It has never been clear-cut but experienced selective cutting and livestock grazing up to 1950 (as evidenced by aerial photographs, dendrochronologic measurements, and site records). The 45-yr-old area is contiguous with the eastern part of the older growth stand and has an elevation of 268 m to 274 m.

To estimate the change in the presence of *O. umbellatum* in 1-m^2 plots and its density in these two stands, I sampled 100 randomly selected 1-m^2 plots within the same boundaries described in DeMars and Runkle (1992). This sampling was conducted early April 1987, April 9–10, 1993 and May 2, 1994. A chi-square test was used to examine whether *O. umbellatum* presence in 1-m^2 plots significantly changed for 1987 versus 1993, 1987 versus 1994, and 1993 versus 1994 counts.

To estimate reproductive potential, I marked 30 individuals in both sites and measured the reproductive outcomes of each during the 1992, 1993, and 1994 field seasons. I recorded the number of stems that flowered and counted the number of vegetative bulbs that developed at the end of their foliar season. Seed set was not determined because few seeds were produced in this site. In fact, most flowers examined set only 2 or 3 seeds.

In the older growth stand, *O. umbellatum* was obviously dispersing along a previously abandoned path that traversed the site in a north-south direction. This path had a high frequency of canopy openings above it. Here, I measured the distance the dispersing front of stems moved during the spring of 1992, 1993, and 1994. To do this, I flagged the leading edge of 5 clumps of stems and measured the distance the front had moved during these years.

To determine whether *O. umbellatum* can potentially affect native herbaceous vegetation within the Wright State University woods, I established fifty 1-m^2 plots within a larger 30 m × 30 m plot in the older growth site. The larger plot was selected *a priori* so as to include an area with a high density of *O. umbellatum* stems. Within each smaller plot I counted all herbaceous stems present three times during the 1993 growing season. The relative frequency (percentage of total number of stems in plot) of each species was used as an importance value which was input into a detrended correspondence analysis (DCA) ordination (Hill 1979). I chose DCA because it allows for visualization of the major vegetation gradients associated with the sample plots. In this respect, I compared plots containing more than 25% *O. umbellatum* stems, less than 25% *O. umbellatum* stems, and no *O. umbellatum*. Should plots ordinate on DCA axes with respect to these classifications, one can conclude that the relative frequency of *O. umbellatum* significantly affects community composition.

RESULTS AND DISCUSSION

There were significant changes in the occurrence of *O. umbellatum* in 1-m^2 plots between the 1987 and 1993 field seasons, and between the 1987 and 1994 field seasons, but not between the 1993 and 1994 seasons. The older growth site showed a statistically significant increase in the number of 1-m^2 plots containing *O. umbellatum* from 7 to 16 plots during 1987 to 1993 (chi-square = 3.979; $p < 0.05$) and from 7 to 19 plots during 1987 to 1994 (chi-square = 6.366; $p < 0.5$). There was no significant change between 1993 and 1994.

The young site experienced a statistically significant decrease in abundance from 23 to 8 sample plots between 1987 and 1993 (chi-square = 8.589; $p > 0.01$) and from 1987 to 1994 (chi-square = 5.103; p, 0.05). No significant difference occurred between 1993 and 1994.

In the older growth site, the 1993 and 1994 average plot densities of *O. umbellatum* were 33.2 stems/m^2 (standard deviation = 17.5) and 35.1 stems/m^2 (standard deviation = 16.4), respectively. The younger site's density was 2.6 stems/m^2 (standard deviation = 1.3) in 1993 and 3.1 (standard deviation = 1.9) in 1994. Substantial variation in the density of *O. umbellatum* reflects its patchy distribution in the Wright State University woods.

Reproductive potential of *O. umbellatum* also differed between the sites. In the older growth site 6% of the stems flowered in 1992, 11% in 1993, and 7% in 1994. The mean number of daughter bulbs observed was 11.6/stem in 1992, 12.1/stem in 1993, and 14.3/stem in 1994. In the young site 0% of the stems flowered in 1992, 5% in 1993, and 1% in 1994. The mean number of vegetative daughter bulbs was also lower. Only 7.8 bulbs/stem were observed on average in 1992, 6.9/stem in 1993, and 7.7 in 1994.

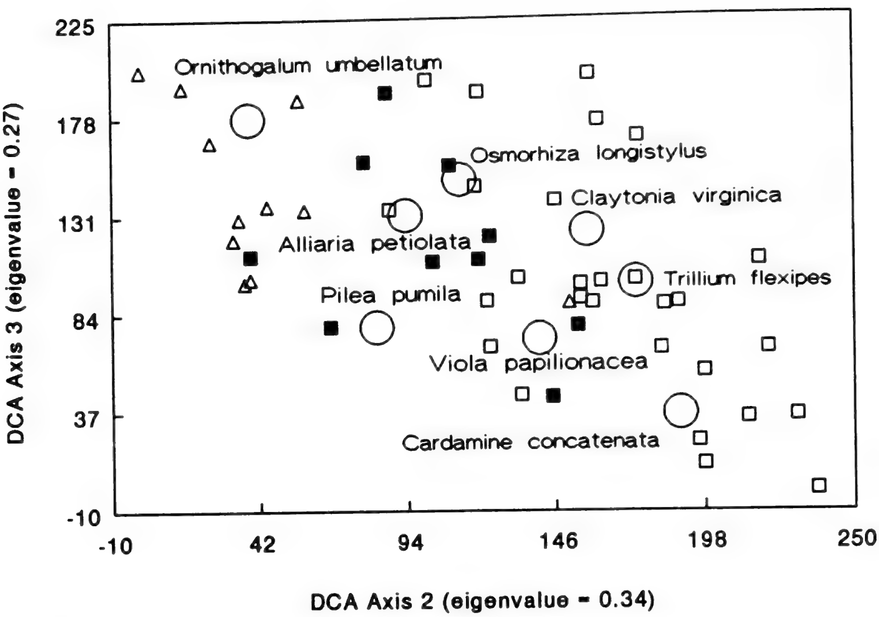

FIGURE 1. 1. Detrended correspondence analysis ordination showing axis 2 and axis 3 scores. Open triangles represent plots with *O. umbellatum* RF > 25%; closed squares represent plots with *O. umbellatum* with RF < 25%; open squares represent plots with *O. umbellatum* RF = 0%; open circles represent ordination scores for overall top 8 species.

The dispersing fronts of *O. umbellatum* stems (along the semi-open path in the older site) moved an averaged 7.8 cm in 1992, 6.0 cm in 1993, and 12.4 cm in 1994. Additionally, longer distance dispersal of bulbs occurred as several new individuals were recorded up to 3 m from the fronts in 1992 and 1993. The longer distance dispersal probably resulted from animal transport of bulbs (occasionally, I noticed that I kicked up some bulbs while walking through the area). However, it should be noted that I cannot be certain that these longer distance dispersal events originated from the fronts I examined. Also, I noticed that some of the isolated bulbs were chewed, suggesting that small mammals or birds might disperse them. Water transport during a late 1993 spring storm was also observed on one occasion. Additionally, seed dispersal was possible, but so few flowers and seeds were produced that this possibility is small.

Axes 2 and 3 of the detrended correspondence analysis (DCA) of 50 sample plots separated plots with a relative frequency (RF) of *O. umbellatum* > 25% from those with RF < 25% and those with no *O. umbellatum* stems (Figure 1). DCA axis 1 arranged plots along a vegetation gradient representing the most accounted for variance among plots (Gauch 1982). Since plots did not ordinate along axis 1 based on the RF of *O. umbellatum* stems, *O. umbellatum* is not the primary determinant of community composition, at least at the 1-m^2 sampling scale. However, DCA axis 2 did ordinate plots based on *O. umbellatum's* RF, suggesting that this species does have a significant effect on the determination of community composition. DCA axis 2 scores were significantly correlated with *O. umbellatum* plot RF's ($r^2 = 0.59$; $p < 0.005$).

A potential factor influencing the plot community composition as represented by DCA axis 2 is disturbance. All sample plots with an *O. umbellatum* RF > 25% were situated in canopy gaps (due to tree falls) or the remains of the abandoned path beneath a semi-open canopy cover. Plots with RF's < 25% or 0% were situated under intact canopies after canopy closure. Hence, *O. umbellatum* displays a preference for canopy gaps. This is so even though the canopy has not yet leafed out while *O. umbellatum* is active ablove ground.

The ordination of species (superimposed on the ordination of sample plots, Figure 1) supports the contention that *O. umbellatum* is specializing in canopy gaps within the Wright State University woods. Several recognized gap specialists ordinated near *O. umbellatum* (Figure 1). *Pilea pumila* (L.) Gray and *Alliaria petiolata* (M. Bieb.) Cavara & Grande ordinated nearest *O. umbellatum* on DCA axis 2, respectively. *P. pumila* is a forest annual which requires intermediate irradiance levels and relatively high soil moisture (Cid-Benevento & Werner 1986). Such factors are characteristic of canopy gap groundlayer environments in mesic forests (Moore & Vankat 1986). *A. petiolata* is also characteristically found in open, disturbed areas within eastern U.S. woodlands (Nuzzo 1993). The other important herb species identified in this study, *Trillium flexipes* Raf., *Claytonia virginica* L., *Cardamine concatenata* (Michx.) O. Schwarz., and *Viola papilionacea* Pursh, are shade-tolerant perennials of non-disturbed deciduous woodland habitat (Bierzychudek 1982) and ordinated on the upper end of DCA axis 2 away from *O. umbellatum*.

The separation of these two groups of species in DCA ordination space suggests that *O. umbellatum* is utilizing disturbed patches within the study sites. The reduction in abundance of *O. umbellatum* in the younger site further supports this hypothesis. Since the first observations of *O. umbellatum* in the younger site (DeMars & Runkle 1992), the canopy has closed tightly (pers. obs.). Such tight canopy closure is common in young wooded stands of *Acer saccharum* in the northeastern United States (Nyland et al. 1986). The tighter closure correlates with the lower abundance of *O. umbellatum*. Moreover, in 1993 and 1994, *O. umbellatum* was found only in plots bordering the open, eastern edge of this site or in plots located near dead *Robinia pseudo-acacia* L. canopy stems. Presumbly, the lower light levels associated with the groundlayer after tighter canopy closure result in an altered environment which does not favor continued establishment of *O. umbellatum* in the younger site.

Another possible cause of increasing *O. umbellatum* success in the Wright State University woods is soil perturbations associated with canopy gaps and paths. Treefalls result in localized soil disturbances (Beatty 1986) which could facilitate *O. umbellatum* invasion and spread. Likewise, the abandoned path in the older site represents an area of disturbed soil. It is also possible that there is an interaction between both the open nature of the canopy and its underlying soil disturbance that facilitates *O. umbellatum* establishment.

The DCA ordination results showed that the vegetation in zero- or low-frequency 1-m^2 plots is different from that in plots containing high frequencies of *O. umbellatum*. Since vegetation change is the result of spatial replacement of individuals (Peet & Christensen 1980), it appears that *O. umbellatum* can out-compete native groundlayer species in moderately disturbed patches. Since I observed several patches of *O. umbellatum* with a density of over 500 stems m^2, this conclusion seems intuitive. However, the establishment of *O. umbellatum* appears to be temporary as evidenced by the decrease in abundance observed in the younger site from 1987 to 1993/1994 and the low abundance in relatively non-disturbed plots.

O. umbellatum appears to replace species with a similar phenology. There were significantly fewer spring ephemeral individuals in plots with RF > 25% *O. umbellatum* (chi-square = 6.467; $p < 0.05$), but for summer herbs there were no significant differences among plots, a result also observed by Rogers (1985).

The distribution of *O. umbellatum* will undoubtedly change through time within the Wright State University woods. Since the species appears to thrive in disturbed patches, the future distribution of the population will probably reflect the gap-phase dynamics of the canopy stratum and future human disturbances. This is not unlikely, since many invasive plants establish in disturbance patches within plant communities (Scorza 1983, Drake 1988, Rejmanek 1989). I conclude that *O. umbellatum* represents an established population in this forest and that it will become a long-term component of the flora, primarily because of its ability to vegetatively reproduce and disperse readily through disturbed areas of the Wright State University woods.

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THE BIG TREES OF MICHIGAN
7. Quercus alba L.

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Michigan's largest known white oak is located in the city of Allegan in Allegan County of Michigan's Lower Peninsula.

Description of the species: Oaks are members of the beech family, Fagaceae. Voss (1985) includes three genera of Michigan trees in this family: *Fagus*, represented only by *F. grandifolia* Ehrh. (American beech), *Castanea*, represented by *C. dentata* (Marshall) Borkh. (American chestnut), and *Quercus* (oaks), represented by seventeen species. *Quercus* can be distinguished from all other trees in our area by their distinctive cupped fruits, commonly known as acorns (Fig. 1). The leaves of oaks are alternate on the branch and range from entire to deeply lobed. The oaks are divided into two subgenera, *Quercus* (white oaks) and *Erythrobalanus* (red oaks), with *Quercus alba* L. belonging to the subgenus *Quercus* (Voss, 1985). The members of this subgenus are distinguished by having leaves with rounded or blunt leaf lobes that lack bristle tips and by acorns which ripen in their first season. The white oak is further characterized by its glabrous leaf undersurface, narrow leaf lobes with rounded tips and deep sinuses, and by its warty or knob-like scales on the acorn cap (Fig. 1).

Location of Michigan's Big Tree: The largest white oak in Michigan is located in the front yard of 1308 Ely Street in the city of Allegan in Allegan County. It is situated 18′ (5.5 m) from the edge of the road and bears an aluminum Michigan Botanical Club identification plaque signifying its State Champion status. The tree can be reached by taking routes M40 or M89 to the River Front Park in Allegan, MI and proceeding to Ely Street just beyond the park. Follow Ely Street 1.1 miles to 1308 Ely Street.

Description of Michigan's Big Tree: The State Champion white oak appears to be healthy, despite a split through the hollow main trunk. The circumference of the tree was measured on August 25, 1993 at 260″ (660 cm) [diameter = 83″ (211 cm)]. This represents an increase of 5″ (13 cm) from Thompson's (1986) measurement of 255″ (647 cm). The height was

[1]Deceased 20 September 1994.

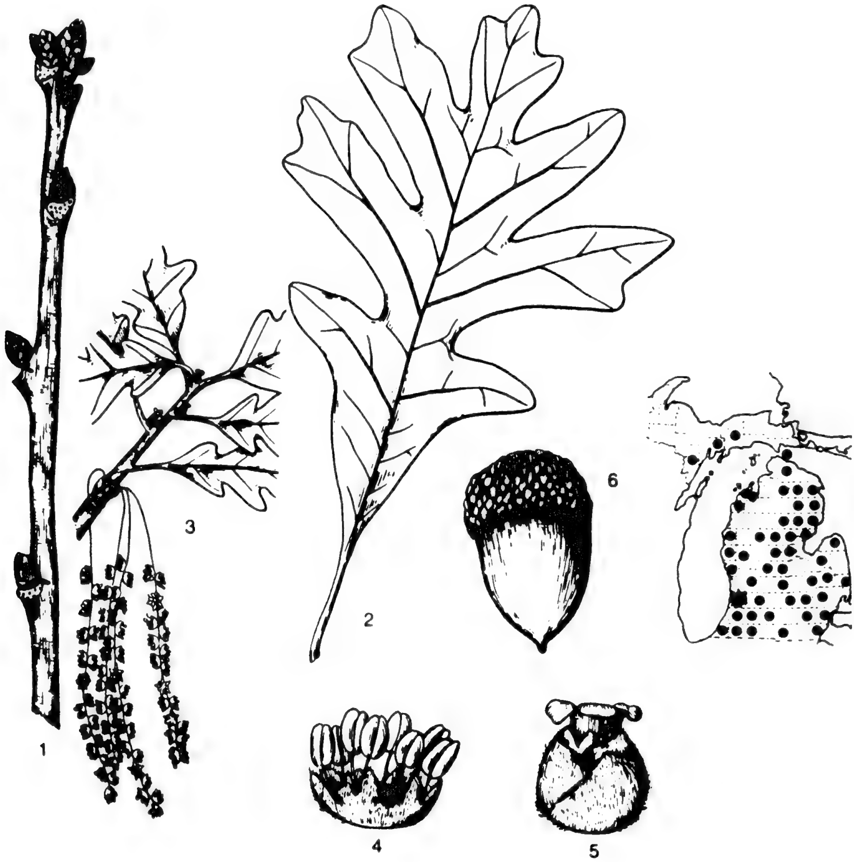

FIGURE 1. Documented distribution in Michigan and characteristics of the white oak. Map is from Voss (1985). The star indicates the location of Michigan's big tree. Drawings are from Barnes and Wagner (1981). 1. Winter twig, ×2; 2. Leaf, ×1/2; 3. Flowering shoot, ×1/2; 4. Male flower, enlarged; 5. Female flower, enlarged; 6. Fruit, acorn ×1.

measured at 84′ (25.6 m), which is 17.5′ (5.25 m) shorter than Thompson's (1986) measurement.

The trunk of the tree diverges into 2 main trunks 11.5′ (3.5 m) above the ground. The crown spread was measured at 125′ (38 m), with crown radii of 70′, 50′, 65′, and 65′. The 22.4% decrease in crown spread from Thompson's (1986) measurement of 161′ (49 m) will not remove its State Champion status, since State Champion trees are determined by girth alone. Voucher specimens from this tree are filed in the Hanes Herbarium (WMU) and the herbaria at Michigan State University (MSC) and the University of Michigan (MICH).

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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On the cover: *Wintergreen* (Gaultheria procumbens)
Photographed by E.B. Mains

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Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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VIOLETS OF MICHIGAN

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Among the first wildflowers every budding naturalist learns are the violets. Everyone can identify violets as a genus (*Viola*) in spite of the confusing array of flower colors, leaf shapes, and growth forms. New gardeners and horticulturists become familiar all too quickly with their amazing reproductive potential; garden plots, lawns, and fencerows are soon overtaken by cultivars of the English violet (*Viola odorata*). Their simple beauty delights woodland visitors of all ages. The impact of violets on an early appreciative soul led to the all but forgotten name of "heartsease" for a relative of the garden pansy, *V. tricolor*. Foragers of wild edible plants gather the early leaves for a tasty potherb, or the abundant blossoms of purple-flowered woodland varieties to make delicious and beautiful jellies and syrups (Gibbons 1966).

Taxonomists who have attempted identification of native violets have usually come to see the cloak of romantic folklore and "innocence" surrounding violets as sheeps' clothing covering a pack of taxonomically incorrigible wolves. Several specialists over the last century have succeeded in describing nearly all conceivable forms of violets—and then some. Many studies have investigated variation and hybridization in some species complexes and groups but have focused predominantly on the two most taxonomically difficult groups, the "stemless" white violets and the "stemless" blue violets. Unfortunately, no published studies of eastern North American violets to date have utilized modern biosystematic methods or evolutionary theory to delineate taxonomic limits or interpret the broader significance of particular variation patterns.

Norman Russell, a violet specialist active during the 1950s and 1960s, published the most geographically complete treatment of *Viola* covering our region. His "preliminary" survey (Russell 1965), the only one of its kind for eastern North America since Brainerd's (1921) report, has remained a useful reference for inferring general morphological and ecological diversity in violets of the eastern half of the continent. The only other taxonomic treatment of a group of violets was published recently by McKinney (1992) for the notorious stemless blue violets of Section *Plagiostigma* Godron, Subsection *Boreali-Americanae* Becker.

The only treatment specifically for violets of Michigan was published by Thompson (1923). Her treatment is based on a small number of specimens previously annotated by Brainerd and his contemporaries, and includes a key, a few notes on morphology and ecology, and county records. Before her Michigan treatment, Beal (1905) reported several violets from the state in his checklist of the Michigan flora. Gleason (1939) followed Thompson's treatment with keys to Michigan's vascular plants, and continued the reports of species mentioned by Beal and Thompson. The treatment presented here is a reevaluation of previous publications and a distillation of confirmed observations regarding the identification, taxonomy, and ecology of Michigan violets. It is intended for an audience already familiar with basic terminology used in plant taxonomy; a useful glossary for unknown terms may be found in Gleason and Cronquist (1991). While it concerns the same taxa treated by Voss (1985) in his Michigan flora, this synopsis also distinguishes additional taxa for which new evidence bearing on their taxonomic status has come to light. The present synopsis also augments Voss's treatment with keys to both flowering and fruiting plants, additional county records for most species, illustrations for each species and variety, and elaboration of habitat and taxonomy. Regional manuals, state and provincial floras for adjoining areas, and an extensive body of North American violet literature have been consulted in an attempt to broaden the applicability and usefulness of the synopsis for the Great Lakes region as a whole.

The synopsis is a reflection of my own field and herbarium studies of the genus in eastern North America. Taxonomic studies since 1979 have utilized approximately 25,000 specimens from over 50 herbaria. Field studies have been conducted throughout Michigan, northern Minnesota, and northern Wisconsin, as well as certain areas of Florida, Illinois, Indiana, Kansas, New York, Ohio, Ontario, and Tennessee. The taxonomic concepts derived from these systematic studies, which are being published piecemeal, have been followed for floristic treatments by Voss (1985) and Ballard (1987).

HERBARIA EXAMINED

Complete collections of Michigan violets from ALBC, ALM, BLH, CMC, IRP, MCTF, MICH, MSC, NM, WMU, and WUD were examined [acronyms follow Holmgren et al. (1990)]. Selected specimens of taxa collected in our state, as well as certain type specimens, have been seen from AUB, BH, CM, CU, GH, MO, MOR, ND, NDG, OS, PH, UMBS, and the private herbaria of the author, Mabel Demorest, Anton A. Reznicek, and Edward G. Voss. Most specimens were examined and annotated during the period from 1982 to 1984, in preparation for Voss's (1985) Michigan Flora Part II. From 1989 to the present, MICH has been periodically revisited to annotate recently accessioned specimens and update the distribution maps. Mapping of specimens follows the methodology employed by Voss (1972, 1985). Computerized records from which the distribution maps are derived are available upon request.

FIGURE 1. Dehisced capsule of stemmed yellow violet, *Viola pubescens*, shows the three valves and arrangement of seeds characteristic of all our violets. (Photo by R. Holzman).

EXCLUDED AND POTENTIAL TAXA

Several taxa have been reported from Michigan that could not be verified through recent, relatively exhaustive herbarium examinations. Boivin (1967) and Ballard (1987) have noted the many erroneous reports, including those of Scoggan (1979), for *V. bicolor* Pursh [an earlier name for *V. rafinesquii*, following the cogent argument by Kartesz & Gandhi (1990)] from Canada. The nearest verified native stations are on Pelee Island, Ontario (Ballard 1987) and the island archipelago of Lake Erie, Ohio (Core 1948). The species is included in the key to accomodate the possibility that it may someday turn up in an alkaline savanna or on limestone cobble shores in southeastern Michigan.

Beal (1905) and Thompson (1923) report the primarily Appalachian *V. rotundifolia* Michx. from Michigan. The nearest recently verified locations for the Carolinian species *V. rotundifolia* (Russell 1965) are in northeastern Ohio and the Niagara Falls area of Ontario and New York (Ballard 1987). The species is excluded, given the distance of the documented main range from Michigan and lack of recent evidence for its occurrence in our state.

The strictly eastern *V. hirsutula* Brain. was reported for Michigan by Beal (1905) [as *V. villosa* Walter] and by Thompson (1923). The taxon ranges no closer to Michigan from its main Appalachian range than north-

FIGURE 2. Striking because of its deeply dissected leaves, the common bird's-foot violet (*Viola pedata*) graces xeric sandy slopes and open forests over much of the Lower Peninsula. (Photo by R. Holzman).

eastern Ohio (Russell 1965). The Michigan report was probably based on a misidentified specimen of *V. sororia*, and the species is excluded.

A potential addition to the state's violet flora, and therefore included in the keys as such, is *V. hastata* Michaux, the halberd-leaved violet, which resembles the single-stemmed *V. pubescens* var. *pubescens* but with glabrous foliage and sagittate cauline leaves. It is predominately Appalachian in distribution but has been reported (Russell 1965) from mesic forests in northern Ohio near Lake Erie. It has been incorporated into the key to species as a remote potential addition to the state's violet flora.

While *V. lanceolata* var. *vittata* has been reported by Russell (1965) from northwestern Indiana and northeastern Illinois, and might be considered a potential addition to our flora, Swink and Wilhelm (1979) did not consider their plants to be good matches for linear-leaved var. *vittata* from the southeastern coastal plain. Until these Great Lakes specimens receive adequate investigation, the Great Lakes reports of *V. lanceolata* var. *vittata* are considered suspect, and the variety is excluded.

Other potential additions include such crosses as *V. adunca* × *rostrata*, *V. adunca* × *striata*, *V. canadensis* × *pubescens*, and *V. macloskeyi* × *renifolia*. These should be sought wherever the parent species grow in proximity.

RECOGNIZING GROUPS OF VIOLETS

Taxa in the genus *Viola* fall quite naturally into morphologically, ecologically, and cytologically discrete groups (Clausen 1927, 1929; Gershoy 1928, 1934; Valentine 1962). To facilitate familiarity with and identification of Michigan violets, the format of this synopsis emphasizes these groups. Important morphological features of violets are illustrated in Fig. 4. Group characteristics, using some of these morphological features, are compiled in Table 1, and reflect in part the concepts of Clausen (1929) as well as current studies on phylogenetic relationships and infrageneric classification of New World *Viola*. Pending publication of these new data, the names of formally recognized sections and subsections are used as informal group names all at the same level, in the spirit in which Voss (1972) used certain sectional names in grouping *Carex* species. The one Michigan species of the genus *Hybanthus* is treated as a member of its own group. The 23 Michigan species of the genus *Viola* recognized in this synopsis are arranged alphabetically within the remaining six groups.

HYBRIDS

Interbreeding between different groups, apparently an exceedingly rare event, has been reported only twice in North America (Brainerd 1909, Forbes 1909), and remains to be confirmed. Conversely, interbreeding has frequently been reported among sympatric taxa of the Boreali-Americanae

FIGURE 3. The woolly blue violet, *Viola sororia*, is perhaps the archetypal violet to naturalists. (Photo by R. Holzman).

group (numerous papers by Brainerd, summarized in Brainerd 1924; McKinney & Blum 1981; Russell 1952, 1955b, 1956b; Russell & Risser 1960), the Viola group (Ballard 1990a, 1990b, 1992, 1993; Valentine 1981), and the Plagiostigma group (Anderson 1954, Russell 1954a). The problem of seemingly unrestricted hybridization (mediated only by habitat specific-

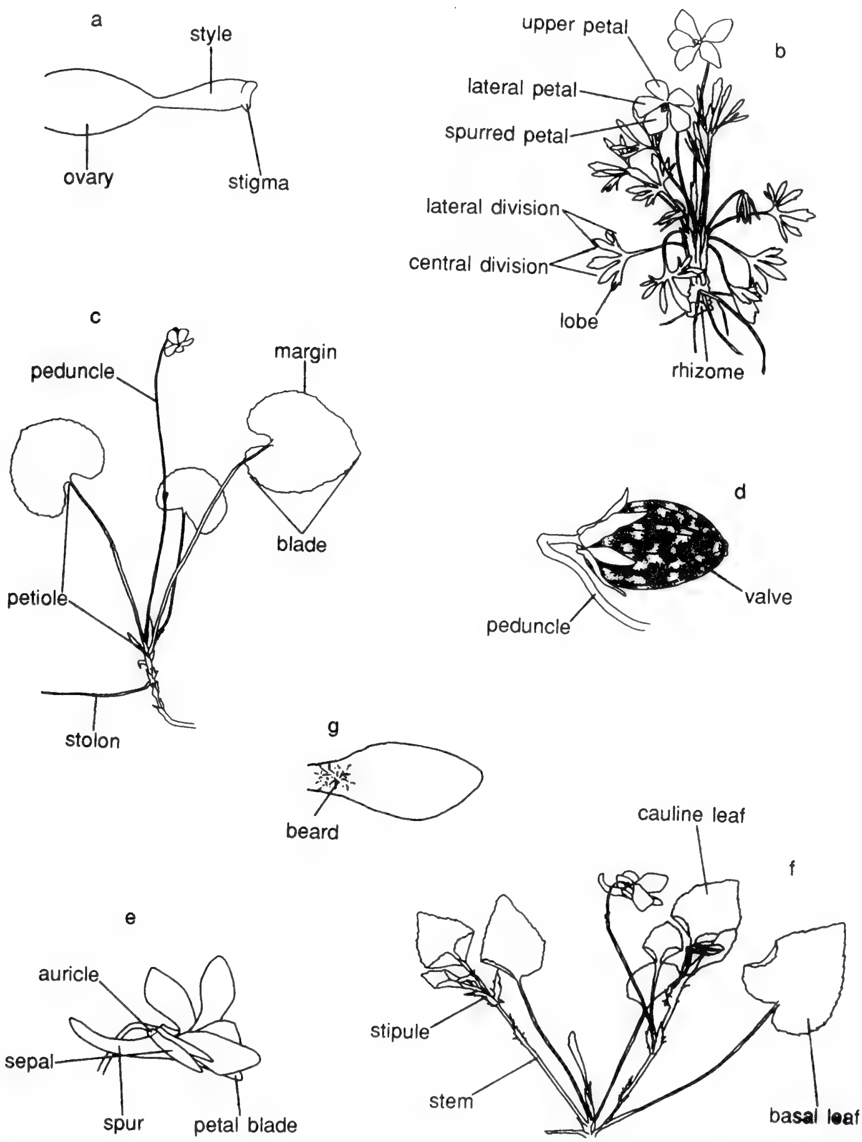


FIGURE 4. Basic violet morphology: (a) gynoecium of *V. pedata*, (b) *V. pedata*, (c) *V. blanda*, (d) capsule of *V. blanda*, (e) flower of *V. rostrata*, (f) *V. rostrata*, (g) beard on lateral petal of *V. sagittata*.

TABLE 1: Predominating characteristics of infrageneric groups* as represented in Michigan

Character	CHA	MEL	VIO	PLA	VIM	PED	BOR
habit	perennial	annual	perennial	perennial	perennial	perennial	perennial
rootstock	ascending rhizome	vertical taproot	ascending rhizome	stoloniform rhizome	ascending rhizome	vertical rhizome	ascending rhizome
aerial stems	+	+	+/-	-	-	-	-
stolons	-	-	-/+	+/-	+	-	-
stipules	free	free	free	free	adnate	adnate	free
stipule margins	erose	lobed	lacerate	ciliate	ciliate	ciliate	ciliate
leaf shape	ovate to reniform	obovate-spatulate	triangular to reniform	lanceolate to reniform	ovate	ovate to reniform	triangular to reniform
leaf margin	serrate to subentire	crenate	crenulate to subentire	serrate to subentire	crenate	dissected	dissected to serrate
corolla	yellow or white	multicolor	cream or violet	white or violet	violet	violet	violet
lateral petal beards	+	+	+/-	+/-	-	-	+
spurred petal beard	-	-	-	-	-	-	+/-
spur	very short	short	moderate to very long	very short	moderate	short	very short
cleistogamy	+	+	+	+	+	-	+
cleist. capsule color	green or spotted	green	green or spotted	green or spotted	spotted	green	green or spotted
seed color	brown	brown	brown	brown,gray or black	brown	brown	brown or black
chromosomes: $2n=$	12,24	26,34	20	24,44	24	54	54

*Acronyms for groups are: CHA = Chamaemelanium, MEL = Melanium, VIO = Viola, PLA = Plagiostigma, VIM = Violidium, PED = Pedatae, BOR = Boreali-Americanae ity) in the Boreali-Americanae in particular has made the genus *Viola* infamous among lay taxonomists and violet specialists alike.

Although all putative hybrid populations recognized in this treatment have been designated with the traditional "×" preceding the second binomial epithet, hybrids have been addressed in two different ways in this treatment, depending on their ecology and relative frequency of occurrence in nature. The first class of hybrids includes infrequent to very rare crosses in the Viola and Plagiostigma groups, in which first-generation hybrids appear to constitute most if not all of the specimens. Their strict morphological intermediacy, low pollen fertility and cleistogamous seed production, and restriction to ecotonal or otherwise intermediate habitats with one or both parents has encouraged the designation of these taxa as traditional interspecific hybrids. Hybrids of this type are briefly described following the species recognized in each group, and are mapped but not illustrated. Although crosses among the Boreali-Americanae species are comparatively quite fertile, and all possible combinations could eventually be found, the majority of these hybrid populations are also highly restricted in distribution, occur only rarely, and appear generally to remain first-generation hybrids due to the restricted nature of "intermediate" ecotone available to them. These are interesting, but their rarity carries relatively little significance to the identification of commonly encountered violet populations. A laundry list of documented hybrid combinations involving the Boreali-Americanae would add little to this treatment.

The second and more complicated class of hybrids includes a Plagiostigma cross (*V. lanceolata* × *macloskeyi*) and two Boreali-Americanae crosses (*V. pedatifida* × *sororia* and *V. sagittata* × *sororia*). These are also designated by the "×" symbol, but are keyed out, mapped, illustrated and discussed in some detail. They are treated differently because of their comparatively frequent occurrence in the state, because they have traditionally been considered (at least by some taxonomists) to be distinct species, and because their taxonomic and biological status is complex.

While most colonies of *V. lanceolata* × *macloskeyi* are subfertile, individuals in a few isolated sites (including Michigan's western Upper Peninsula) produce—possibly through backcrosses—abundant and viable cleistogamous seeds. These *de novo* fertile populations are essentially identical to the sterile progenitors (except for well-developed cleistogamous capsules and seeds) and to the coastal plain *V. primulifolia* (except for distribution). The latter taxon is itself suspiciously both morphologically and ecologically intermediate between *V. lanceolata* and *V. macloskeyi*, raising the intriguing question of whether the coastal plain populations are of more ancient hybrid origin. Great Lakes populations are named in this treatment *V.* ×*primulifolia*, both to designate their recurrent, *de novo* origin in the region and to indicate that a much greater taxonomic problem exists regarding the relationship of our populations to those on the Atlantic and Gulf coasts, and the evolutionary history and taxonomic status of coastal *V. primulifolia* itself.

The two widespread Boreali-Americanae hybrids are largely pollen fertile

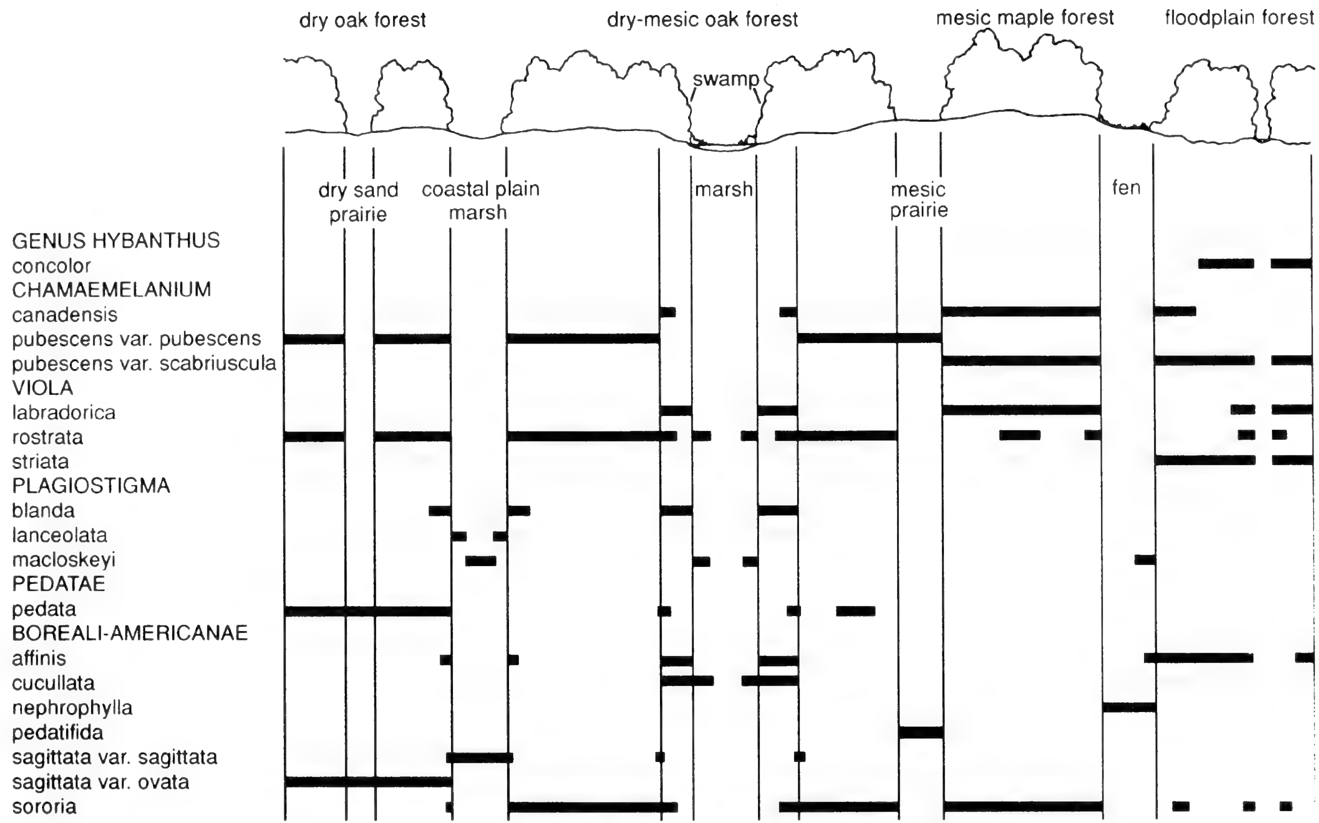


FIGURE 5. Characteristic distributions of Michigan violets along an imaginary transect bisecting natural communities of the southwestern Lower Peninsula (see text for further details). Taxa are grouped together as in the TAXON DISCUSSIONS for comparative purposes.

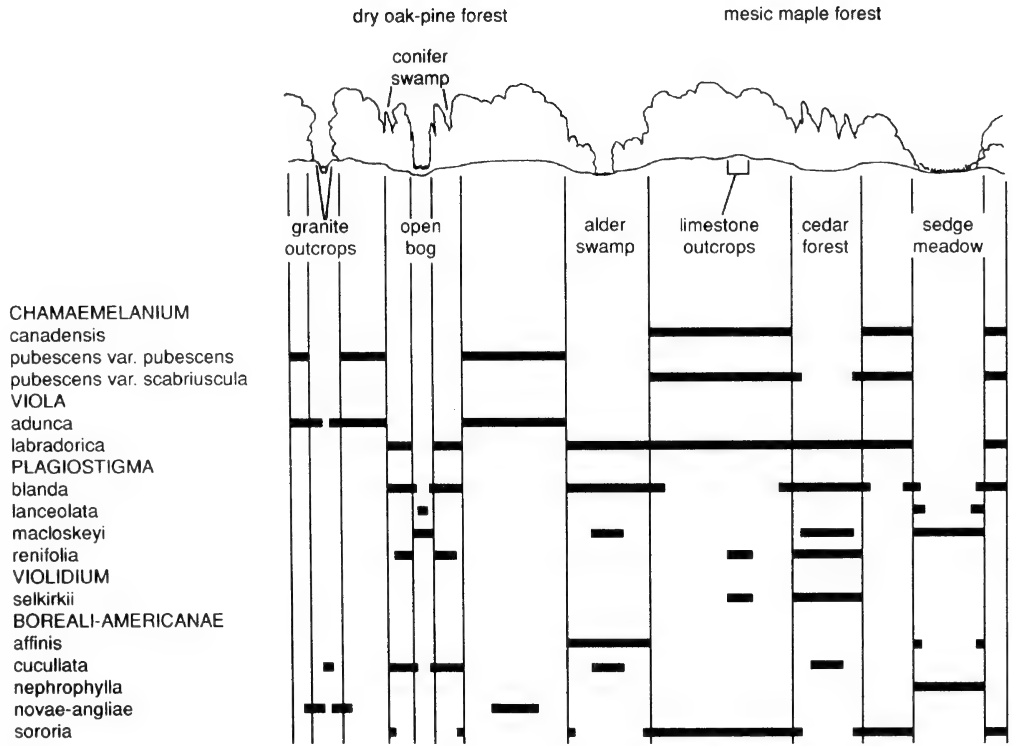


FIGURE 6. Characteristic distributions of Michigan violets along an imaginary transect bisecting natural communities of the western Upper Peninsula (see text for further details). Taxa are grouped together as in the TAXON DISCUSSIONS for comparative purposes.

and immediately produce well-developed cleistogamous seeds, often proliferating hybrid swarms where "intermediate" conditions in the sense of Anderson (1948) are well-represented in the local area of parental species sympatry. In most crosses of this class, the hybrid swarms are restricted to an ecotonal or otherwise conspicuously and consistently disturbed habitat and are often still associated with one or both parents. Larger hybrid swarms may fill the entire morphological and ecological gap between two locally co-occurring species. Derivatives of the initial crosses quickly breed "true" from cleistogamous seeds over a very few generations (see Ezra Brainerd's early papers), and, except for first-generation hybrid individuals, typically resemble one of the parents more closely in both morphological features and habitat. In both *V. pedatifida* × *sororia* (designated *V.* ×*subsinuata*) and *V. sagittata* × *sororia* (designated *V.* ×*palmata*), the situation is roughly analagous to that of *V.* ×*primulifolia*. Great Lakes populations appear to be very recently derived and, in some sites, are still largely restricted to ecotones or disturbed microsites near one or both parents, while in the Appalachian region, morphologically indistinguishable populations that may also be of hybrid origin, but are presumably much older, thrive apart from the putative parents. These scenarios are discussed in more detail under *V.* ×*palmata*, *V.* ×*primulifolia* and *V.* ×*subsinuata*.

HABITAT

Field observations of the genus have suggested that nearly all species (and to a lesser extent, varieties recognized here) within particular groups have narrow ecological tolerances, and inhabit specific microhabitats within recognizable habitats. Species within groups commonly express modally distinct ecological differences as well as unique geographic ranges, and are distributed non-randomly across the Michigan landscape. Local distributions probably reflect genetically determined tolerances of soil pH, moisture, and texture.

This ecological separation among taxa within specific groups has been consistently encountered throughout Michigan and other locations in eastern North America. For such groups as the stemless blues (Boreali-Americanae group), habitat has been adopted and stressed as an invaluable aid in the identification of superficially similar taxa. Two hypothetical cross-sections of local landscape representing habitats in the southwestern Lower Peninsula (Fig. 5) and the north-central Upper Peninsula (Fig. 6) illustrate microgeographic and microhabitat distribution in our state's *Viola* species and varieties. The two cross-sections are a simplification of natural features along two transects, the first running from Saugatuck, Van Buren County southeast to Battle Creek, Calhoun County in the Lower Peninsula; the second, from Escanaba, Delta County to Watersmeet, Gogebic County in the Upper Peninsula.

KEYS TO SPECIES

In the following keys, description of corolla color pattern (except in the Viola group) ignores the hidden white throat inside the corolla tube as well as the nectar guide lines on the spur petal blade. For species with aboveground stems, character states of stipules and leaves refer to median and upper cauline structures. Capsule color refers to cleistogamous capsules, which can be identified by the tiny, tightly curled style at the apex of one of the valves. Seed size and color describe only seeds from fully mature, recently or naturally dehisced capsules. Potential additions to the state flora, keyed below, are enclosed within brackets ([]) but are not addressed further in taxon discussions. Keys to infraspecific taxa (varieties and forms) are presented under each species heading.

KEY FOR FLOWERING SPECIMENS

1. Plant caulescent (stemmed), with leaves and flowers arising from these erect or ascending stems
    2. Leaves 10 or more per stem; plant 30–100 cm tall .... 1. *Hybanthus concolor*
    2. Leaves up to 8 per stem; plant usually less than 30 cm tall (*Viola*)
        3. Corolla solid yellow or white w/yellow center; stipules entire or jagged along margins, scarious or herbaceous (CHAMAEMELANIUM GROUP)
            4. Corolla white with yellow center; stipules long-acuminate, narrowly acute at apex, tapering from base to tip, scarious .... 2. *V. canadensis*
            4. Corolla solid yellow; stipules ovate, acute or obtuse at apex, commonly broadened above base before tapering to apex, herbaceous
                5. Leaves hastate, much longer than broad, long-tapering to an acute apex, strongly cordate at base; foliage glabrous; not yet known in Michigan, should be sought in rich woods of the southeastern counties .... [*V. hastata*]
                5. Leaves ovate, as broad as or broader than long, obtuse or abruptly acute at apex, cordate to truncate at base; foliage glabrous to densely pubescent; widespread throughout the state .... 3. *V. pubescens*
        3. Corolla cream-white to yellow-orange, or lavender to blue, with or without yellow center; stipules fringed or deeply lobed
            6. Stipules deeply lobed near base with oblong or spatulate segments at least 1/4 as long as whole stipule (MELANIUM GROUP)

7. Corolla pale blue with yellow center; flowers less than 1.5 cm long; lateral petals ca. 2 times as long as sepals . . . .[*V. bicolor*]
7. Corolla cream or yellow-orange with yellow center, upper petals sometimes dark blue at tips; if flowers less than 1.5 cm long, then lateral petals shorter than sepals or scarcely exceeding them
    8. Petals shorter than sepals or surpassing them by no more than 2 mm; all five cream on distal half, about equal in length . . . . .4. *V. arvensis*
    8. Petals longer than sepals, the upper pair dark blue or purple on distal half, longer than the lower three . . . . .5. *V. tricolor*
6. Stipules fringed with thread-like or long-triangular segments less than 1/4 as long as whole stipule (VIOLA GROUP, in part)
    9. Leaves narrowly ovate to triangular, ±truncate at base, tapering to rounded apex, subentire along margins; corolla dark blue; foliage commonly densely short-pubescent with minute hairs . . . . . .6. *V. adunca*
    9. Leaves ovate to reniform, obtuse or apiculate to acute at apex, crenate to crenulate to serrate along margins; corolla cream-white, lavender or light blue; foliage glabrous or sparingly pubescent
        10. Corolla solid cream-white; spur less than 4mm long, up to 1/4 as long as whole spurred petal; sepal margins ciliate; leaf margins regularly crenulate . . . . 10. *V. striata*
        10. Corolla variously light blue or lavender; spur commonly over 5mm long, more than 1/4 as long as whole spurred petal; sepal margins not ciliate; leaf margins not regularly crenulate
            11. Corolla solid light blue; lateral petals bearded within; cauline leaves broadly ovate to reniform, apiculate or broadly tapering to an obtuse (infrequently an acute) apex, low-crenate along margins . . . . . 7. *V. labradorica*
            11. Corolla light blue to lavender with dark purple eyespot; lateral petals not bearded within; cauline leaves ovate to oblong-ovate, especially the upper becoming strongly acute or acuminate, remotely serrate along margins . . . . 9. *V. rostrata*

1. Plant acaulescent (stemless), the leaves and flowers arising independently and directly from the rootstock
    12. Style tipped by a slender, recurved conic hook; stolons green, stiff

and cord-like; European escape of lawns and suburban woodlots (VIOLA GROUP, in part) ....8. *V. odorata*

12. Style merely expanded into a short scoop-shaped tip; stolons slender and pale or absent; native species of natural habitats
    13. Spur over 2 times longer than thick; all petals glabrous within; corolla blue (VIOLIDIUM GROUP)..........24. *V. selkirkii*
    13. Spur less than 2 times longer than thick; lateral or spurred petals in some species bearded within; corolla blue or white
        14. Corolla white (except in *V. epipsila* of Keweenaw Co.); spurred petal glabrous within, laterals sometimes bearded; stolons produced (except in *V. renifolia*); rhizomes less than 3 mm thick below crown (PLAGIOSTIGMA GROUP)
            15. Corolla blue........................16. *V. epipsila*
            15. Corolla white
                16. Leaf blades more than 1.5 times as long as broad
                    17. Leaf blades lanceolate, narrowly cuneate at base ....17. *V. lanceolata*
                    17. Leaf blades lance-ovate, broadly cuneate to subcordate at base......23. *V. ×primulifolia*
                16. Leaf blades less than 1.5 times as long as broad (often broader than long)
                    18. Leaf blades dull, strictly glabrous on both sides (but petioles often villous), the underside not paler than the upper surface, orange-tinged when dried; margins low-crenate to subentire....................18. *V. macloskeyi*
                    18. Leaf blades shiny and glabrous above (glabrous or pubescent beneath) or dull and sparsely to densely pubescent on either side, the underside distinctly paler than the upper surface but not orange-tinged when dried; margins serrate
                        19. Plants strongly stoloniferous, rhizomes horizontal; largest leaf blades obtuse at apex, midrib length at least 3/4 of blade width; both surfaces of blades varying from sparsely to densely pubescent with short hairs less than 1 mm long .... 15. *V. blanda*
                        19. Stolons absent, rhizomes ±vertical (although sometimes twisted); largest leaf blades commonly reniform, truncate at apex (occasionally round), midrib length mostly 3/4 or less of blade width; leaf blades commonly either glabrous and shiny above (varying from glabrous to

pubescent beneath) *or* densely pubescent above (and glabrous beneath) with hairs about 1 mm long........19. *V. renifolia*

14. Corolla purple; lateral and, sometimes, spurred petal bearded within (except in *V. pedata*); stolons never produced; rhizomes usually more than 3 mm thick below crown
    20. Corolla frontally flattened in life, the tips of the orange stamens exposed; lateral petals glabrous within; stipules adnate (PEDATAE GROUP).....25. *V. pedata*
    20. Corolla with petals oriented forward in life, the stamens not exposed; lateral and, often, spurred petals bearded within; stipules free (BOREALI-AMERICANAE GROUP)
        21. Leaf blades lobed or divided
            22. Leaf blades divided nearly to summit of petiole into slender, linear segments .... 30. *V. pedatifida*
            22. Leaf blades coarsely incised or lobed, the sinuses reaching up to ca. halfway to summit of petiole, the segments triangular to ovate or reniform
                23. Leaf blades much longer than broad; coarse teeth or linear-oblong lobes restricted to lowest fourth or third of blade; sepals long-tapering, sharply acute at apex; spurred petal heavily bearded within..................31. *V. sagittata*
                23. Leaf blades scarcely if at all longer than broad; lobes triangular to broadly ovate, reaching up to or beyond middle of blade margin; sepals oblong, obtuse or rounded at apex; spurred petal glabrous or bearing a few hairs within
                    24. Early spring (outermost) and late summer (innermost) leaf blades unlobed; central division of mid-season blades unlobed, the lateral divisions lobed.....33. *V. ×palmata*
                    24. All leaf blades lobed; central lobe of midseason blades deeply lobed like the lateral divisions..34. *V. ×subsinuata*
        21. Blades merely serrate along margins
            25. Most or all leaf blades distinctly longer than broad
                26. Foliage glabrous or nearly so; sepals not ciliate; plants of wet habitats
                    27. Lateral petals bearded within by long

thread-like hairs; spurred petal densely bearded within; young cleistogamous flowers arising on initially prostrate peduncles ....26. *V. affinis*

27. Lateral petals bearded within by short knob-shaped hairs; spurred petal glabrous within; young cleistogamous flowrs arising on erect peduncles ... . 27. *V. cucullata*

26. Foliage sparsely to densely pubescent; sepals usually ciliate; plants of dry habitats

28. Sepals lance-ovate, broadly rounded at apex; foliage pubescence of long (over 1 mm long) hairs; central and western Upper Peninsula .... 29. *V. novae-angliae*

28. Sepals long-tapering to a sharply acute apex; foliage pubescence of short (less than 1 mm long) hairs; southern Lower Peninsula .... 31. *V. sagittata*

25. Most or all leaf blades nearly as broad as long, or broader

29. Sepals long-tapering, sharply acute at apex, with well developed auricles; lateral petals bearded within by short, knob-shaped hairs; spurred petal glabrous within; flowers commonly overtopping leaves ....27. *V. cucullata*

29. Sepals oblong to lance-ovate, obtuse to rounded at apex, with inconspicuous auricles; lateral (and often the spurred) petals bearded within by long, thread-like hairs; if spurred petal glabrous within, then flowers overtopped by the leaves

30. Flowers commonly overtopping leaves (especially in early anthesis); foliage essentially glabrous; largest leaf blades mostly obtuse to rounded at apex, truncate to subcordate at base, crenate along margins; spurred petal typically densely bearded within; plants of wet, alkaline, open habitats ....28. *V. nephrophylla*

30. Flowers commonly overtopped by leaves; foliage commonly moderately

to densely longpubescent; largest leaf blades often acute to abruptly short-acuminate at apex, strongly cordate at base, serrate along margins; spurred petal glabrous (in southern plants) to scantily bearded (in northern plants) within; plants of moist to dry forest habitats . . . . 32. *V. sororia*

KEY FOR FRUITING SPECIMENS

1. Plant caulescent (stemmed), with leaves and flowers arising from erect or ascending stems
   2. Leaves 10 or more per stem; plant 30–100 cm tall . . . . 1. *Hybanthus concolor*
   2. Leaves fewer than 8 per stem; plant usually less than 30-cm tall (*Viola*)
      3. Stipules entire or slightly jagged along margins, scarious or herbaceous (CHAMAEMELANIUM GROUP)
         4. Stipules long-acuminate, narrowly acute at apex, tapering from base to apex, scarious, often deciduous . . . . 2. *V. canadensis*
         4. Stipules ovate, acute to obtuse at apex, commonly broadened above base before tapering to apex, herbaceous and persistent
            5. Leaves hastate, much longer than broad, long-tapering to an cute apex, strongly cordate at base; foliage glabrous; not yet known in Michigan, should be sought in rich woods of the southeastern counties . . [*V. hastata*]
            5. Leaves ovate, as broad as or broader than long, obtuse or abruptly acute at apex, cordate to truncate at base; foliage glabrous to densely pubescent; widespread throughout the state . . . . 3. *V. pubescens*
      3. Stipules fringed or deeply lobed along margins, herbaceous
         6. Stipules deeply lobed near base with oblong or spatulate segments at least 1/4 as long as whole stipule (MELANIUM GROUP)
            7. Leaves and terminal lobes of stipules entire, the latter palmately lobed in basal third . . . . [*V. bicolor*]
            7. Leaves and terminal lobes of stipules crenulate, the latter pinnately lobed in basal third
               8. Stem minutely pubescent on faces as well as angles . . . . 4. *V. arvensis*
               8. Stem glabrous on faces, pubescent or glabrous on angles . . . . 5. *V. tricolor*
         6. Stipules fringed with thread-like or long-triangular seg-

ments less than 1/4 as long as whole stipule (VIOLA GROUP, in part)

9. Leaves narrowly ovate to triangular, truncate at base, tapering to rounded apex, subentire along margins; foliage commonly puberulent ....6. *V. adunca*
9. Leaves ovate to reniform, cordate at base, obtuse to apiculate or acute at apex, crenate to crenulate or serrate along margins; foliage glabrous or sparingly pubescent
    10. Sepals of cleistogamous capsules ciliate, auricles elongate, quadrate, spreading; leaves ovate, acuminate at apex, regularly crenulate along margins; stipules lance-ovate to ovate, heavily fringed .... 10. *V. striata*
    10. Sepals of cleistogamous capsules eciliate, auricles short, rounded, appressed; leaves ovate to reniform, acute to obtuse or apiculate at apex, crenate or serrate along margins; stipules lance-linear to narrowly oblong, sparingly fringed
        11. Cauline leaves broadly ovate to reniform, apiculate or broadly tapering to an obtuse or acute apex, low-crenate along margins; stipules commonly less than 1.5 cm long .... 7. *V. labradorica*
        11. Cauline leaves ovate, acute at apex, distantly serrate along margins; stipules often more than 1.5 cm long ....9. *V. rostrata*

1. Plant acaulescent (stemless), the leaves and flowers arising independently and directly from the rootstock
    12. Rhizomes less than 3 mm thick below crown; stolons produced (except in *V. renifolia*); leaves never lobed or divided
        13. Capsule pubescent and purple-flecked; leaf blades regularly crenulate, densely short-pubescent, finely rugose above; stolons green, cord-like; European escape of lawns and suburban woodlots (VIOLA GROUP, in part) ....8. *V. odorata*
        13. Capsule glabrous, green or purple-flecked; leaf blades shallowly crenate to serrate or denticulate, glabrous to sparsely or densely pubescent, not conspicously rugose above; stolons (if present) weak and pale; native species of various habitats, not commonly in altered areas
            14. Leaves strongly cordate with narrow sinus, the basal lobes commonly overlapping in life; margins regularly crenate; upper surface of blades with uniformly scattered, erect white hairs; auricles on capsules at least 1 mm long; stipules mostly less than 6 mm long, adnate to petioles for ca. 1/2 their length (VIOLIDIUM GROUP) ......24. *V. selkirkii*
            14. Leaf blades long-tapering to strongly cordate at base with

wide to narrow sinus, the basal lobes (when present) very rarely overlapping in life; blades crenate to denticulate and glabrous *or* serrate and pubescent; auricles on capsules less than 1 mm long; stipules mostly over 7 mm long, never adnate to petiole (PLAGIOSTIGMA GROUP)

15. Leaf blades over 1.5 times as long as than broad
    16. Leaf blades lanceolate, narrowly cuneate at base .... 17. *V. lanceolata*
    16. Leaf blades lance-ovate, broadly cuneate to subcordate at base [*V. blanda* ×*lanceolata* would key here] .... 23. *V.* ×*primulifolia*
15. Leaf blades less than 1.5 times as long as than broad (often broader than long)
    17. Leaf blades dull, strictly glabrous on both sides (but petioles often villous), the underside not distinctly paler than upper surface; margins crenate or serrate capsules green, on erect peduncles
        18. Leaf margins serrate, lower and upper surfaces similar in color; mature seeds over 1 mm long, gray-black; Keweenaw Co. .... 16. *V. epipsila*
        18. Leaf margins shallowly crenate, the underside orange-tinged; mature seeds less than 1 mm long, olive-black; widespread throughout the state .... 18. *V. macloskeyi*
    17. Leaf blades shiny and glabrous above, or dull and sparsely to densely pubescent, the underside distinctly paler; margins serrate; capsules purple-flecked, on prostrate to arching peduncles
        19. Plants strongly stoloniferous, rhizomes mostly horizontal; largest leaf blades obtuse at apex, midrib length usually 3/4 or more of blade width; both surfaces of blades varying from sparsely to densely pubescent with short hairs ca. 1 mm long .... 15. *V. blanda*
        19. Stolons absent, rhizomes more or less vertical (although sometimes twisted); largest leaf blades commonly reniform, truncate at apex (occasionally round), midrib length mostly 3/4 or less of blade width; leaf blades commonly either glabrous and shiny above (varying from glabrous to pubescent beneath) *or* densely pubescent above (and glabrous beneath) with hairs approaching 2 mm long .... 19. *V. renifolia*

12. Rhizomes stout, usually well over 3 mm thick; stolons absent; leaves in some species lobed or divided
    20. Leaves deeply dissected into linear segments, petioles attached

well below ground level on rhizome; stipules over 1.5 cm long and adnate to petioles for most of their length; rhizome vertical, short, barrel-shaped; cleistogamous capsules never produced (PEDATAE GROUP)........................25. *V. pedata*

20. Leaves deeply dissected, coarsely lobed or merely serrate along margins, petioles attached at or immediately just below ground level on rhizome; stipules less than 1.5 cm long and free from petioles; rootstock prostrate-ascending, slender; cleistogamous capsules produced from early summer to fall (BOREALI-AMERICANAE GROUP)
    21. Leaf blades coarsely serrate at base, lobed, or deeply divided
        22. Blades divided nearly to the summit of the petiole into slender, linear segments; cleistogamous capsules green, on erect peduncles; rare species of mesic prairies and similar sites ....31. *V. pedatifida*
        22. Blades coarsely incised at base or lobed, sinuses generally not reaching more than halfway to summit of petiole, the segments linear-oblong to reniform; cleistogamous capsules green, on erect peduncles or purple-flecked, on prostrate peduncles; species mostly of forested or wetland sites
            23. Blades more than 1.5 times as long as broad; lowest 1/3 to 1/4 of blades coarsely serrate or divided into short, linear-oblong segments; cleistogamous capsules green, on erect peduncles ...31. *V. sagittata*
            23. Blades less than 1.5 times as long as broad; margins of blades coarsely serrate or divided into triangular to ovate lobes, the segments extending beyond middle of blade; cleistogamous capsules purple-flecked, on prostrate or arched peduncles
                24. Early spring (outermost) and late summer (innermost) leaf blades unlobed; central division of mid-season blades unlobed, the lateral divisions lobed ....33. *V.* ×*palmata*
                24. All leaf blades lobed; central lobe of midseason blades deeply lobed like the lateral divisions...................34. *V.* ×*subsinuata*
    21. Leaf blades merely serrate along margins
        25. Most or all leaf blades distinctly longer than broad
            26. Foliage sparsely to densely pubescent; sepals or auricles ciliate; species of mesic to dry habitats
                27. Leaves held erect in life; capsules purple flecked, on basally prostrate and terminally ascending peduncles; sepal tips broadly rounded; rare in central and west-

ern Upper Peninsula, disjunct in Crawford Co............29. *V. novae-angliae*

27. Leaves held erect (in var. *sagittata*) or prostrate in life (in var. *ovata*); capsules green, on erect peduncles; sepal tips narrowly and sharply acute; widespread in Lower Peninsula, also in southern Menominee Co..........31. *V. sagittata*

26. Foliage glabrous or nearly so; sepals sepals and auricles typically not ciliate; species of wet habitats

28. Cleistogamous capsules purple-flecked, on prostrate or arched peduncles; auricles less than 2 mm long; mature seeds light brown ....26. *V. affinis*

28. Cleistogamous capsules green, on erect peduncles; sepals long-tapering, sharply acute at apex; auricles 2–10 mm long; mature seeds olive-black .... 27. *V. cucullata*

25. Most or all leaf blades nearly as broad as long, or broader

29. Foliage commonly pubescent; cleistogamous capsules purple-flecked, on prostrate peduncles; mature seeds light brown; plants of moist to dry forest habitats ....32. *V. sororia*

29. Foliage glabrous; cleistogamous capsules green, on erect peduncles; mature seeds olive-black; plants of wet (marsh and swamp) habitats

30. Auricles 3–10 mm long; sepals long-tapering, sharply acute at apex; species of circumneutral to acidic wetlands and swamps................27. *V. cucullata*

30. Auricles less than 2 mm long; sepals oblong, obtuse to rounded at apex; species of alkaline wetlands .... 28. *V. nephrophylla*

TAXON DISCUSSIONS

This synopsis recognizes 38 distinct native and exotic violet taxa in Michigan, including 2 genera, 24 species, 10 hybrids, 2 varieties, and 2 forms. Approximately parallel taxonomic treatments, with different ranks for certain taxa, have been used by Ballard (1987) and Voss (1985).

Species are arranged alphabetically within each phylogenetic group, followed by hybrids. Recognized varieties and forms are keyed under the species heading and treated separately, immediately following the typical variety or form. For each species and variety, an illustration providing growth habit and, in most cases, close-ups of specific morphological details are presented with a distribution map. For forms and occasional sterile hybrids in the Plagiostigma and Viola groups, illustrations are not presented, and county records are mentioned in the "COMMENTS" section. The taxonomic and nomenclatural status of three widespread hybrid taxa, *V.* ×*palmata* L., *V.* ×*primulifolia* L. and *V.* ×*subsinuata* Greene, which to the present have been treated variously as distinct species or hybrids, is more complex; these are illustrated, mapped, and discussed at some length following species accounts in their respective groups.

Most previously recognized forms are placed into synonymy under the species, particularly in the case of simple albinos or aberrant plants that are mere curiosities, as these do not appear to warrant formal taxonomic recognition as distinct entities. Forms have been maintained in only two instances: the concolorous and bicolorous corolla color morphs of *Viola pedata* that render the species unique; and the puberulent and glabrous foliage morphs of *Viola adunca* that have previously engendered confusion between *V. adunca* and *V. labradorica*.

For the sake of brevity, synonymy includes only basionyms, names of taxa described from Michigan specimens, and names used in major floras of Michigan and surrounding states and widely used regional violet treatments. Authors of plant names follow Brummitt and Powell (1992). Sources for frequently used scientific and common names include Fernald (1950), Gleason (1952), Gleason and Cronquist (1991), Jones and Fuller (1955), Mohlenbrock (1978), Russell (1965), Scoggan (1979), and Voss (1985).

Genus *Hybanthus* Jacq.

1. *H. concolor* (T. F. Forst.) Spreng., Syst. Veg. 1:805. 1825; Fig. 7.
COMMON NAME: Green violet
TOTAL RANGE: Connecticut west to southern Ontario, southern Michigan and Kansas, south to North Carolina, Georgia, Arkansas, and Missouri.
HABITATS: Floodplain forests of the southern Lower Peninsula.
COMMENTS: The species is very unviolet-like and rather nondescript in appearance, which may lead naturalists to pass it by in the field. This is the only eastern deciduous forest representative of a primarily tropical genus. The genus as a whole is believed to represent the closest relative of *Viola* (Clausen 1927, 1929; Gershoy 1928).

This species is sufficiently rare to earn it "Special Concern" status in Michigan, owing to its limited distribution and restriction to floodplains in our state.

Kovanda (1978) has reported a diploid chromosome number of $2n=48$.

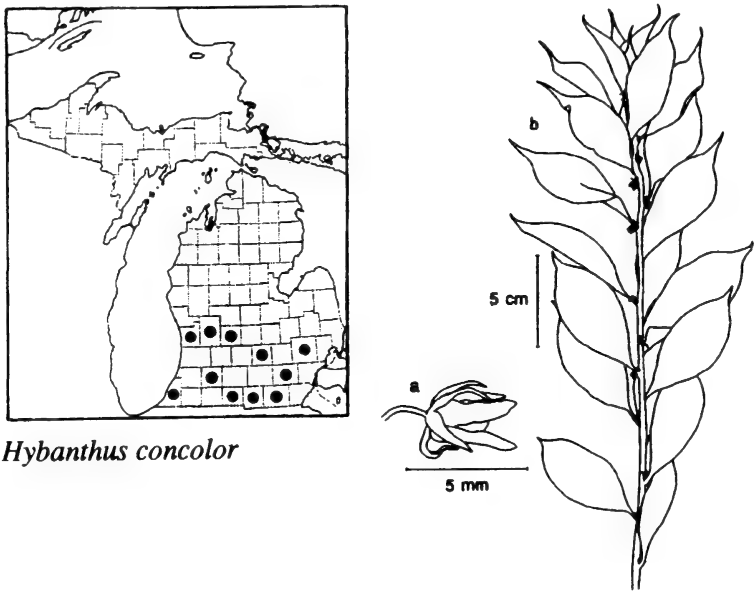


FIGURE 7. *Hybanthus concolor*: Michigan distribution, (a) profile of flower, and (b) spring habit.

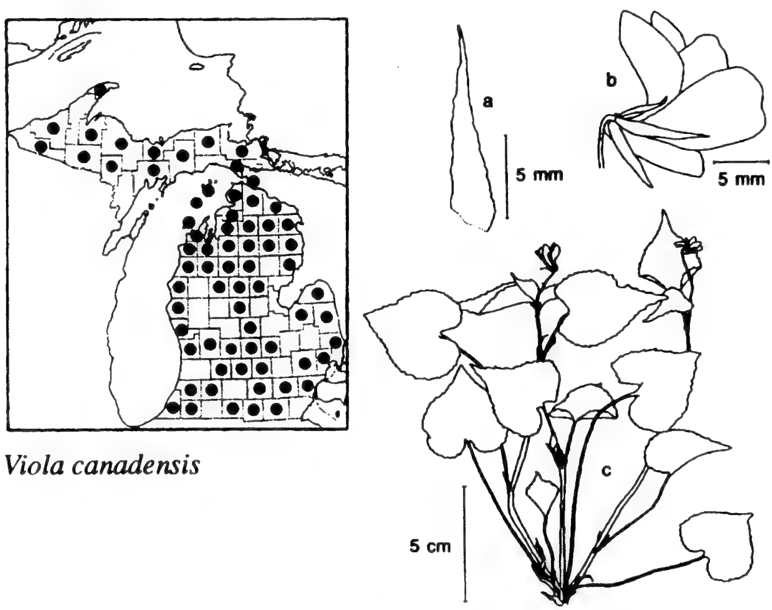


FIGURE 8. *Viola canadensis*: Michigan distribution, (a) upper cauline stipule, (b) profile of flower, and (c) spring habit.

Genus *Viola* [Tourn.] L.

CHAMAEMELANIUM GROUP

2. *V. canadensis* L., Sp. Pl.:936. 1753; cover and Fig. 8.
V. canadensis var. *pubens* Farw., Rep. Michigan Acad. Sci. 19:248. 1917.

COMMON NAME: Canada violet

TOTAL RANGE: Indigenous from Massachusetts and Quebec west to Ontario and Indiana, south to South Carolina and Tennessee; disjunct in Arkansas and Alabama.

HABITATS: Mesic sugar maple forests, typically in circumneutral or alkaline soils.

COMMENTS: This violet is easily separated from *V. striata*, with which it is often confused, by its white corolla with yellow center, petals purplish on the backs, and acuminate, scarious, essentially entire stipules. It superficially resembles *V. striata* in fruit but its stipules, often deciduous in older specimens, will easily distinguish it. In Michigan this species shows less ecological amplitude than *V. pubescens* var. *scabriuscula*, with which it is typically associated, the latter occurring in both wetter and drier forests.

Across its North American range, *V. canadensis sensu lato* shows some morphological variability in cauline leaf shape, degree of serration of leaf margins, pubescence, stem number, and prolongation of rootstock. One of these variants, often recognized as *V. rugulosa* Greene or *V. canadensis* var. *rugulosa* (Greene) Hitchc., has been reported from Wisconsin (Russell 1965), Ontario (Boivin 1966), and states and provinces farther west as well as from the southeastern states, and might be expected in Michigan's western Upper Peninsula. Its taxonomic status is unclear, as specimens named as such from across its range show ambiguity in supposedly diagnostic characteristics. All Michigan material examined, at any rate, matches well with *V. canadensis* in the strict sense.

Farwell (1917a) described var. *pubens* for a decidedly pubescent plant collected near Disco in Macomb County, but his type specimen has not been located.

Both Canne (1987) and Clausen (1929) have reported the species as having $2n = 24$ chromosomes.

3. *V. pubescens* Aiton

KEY TO INFRASPECIFIC TAXA

1. Foliage densely pubescent; stems 1–2; basal leaves 0–1; cauline leaves obtuse at apex, cuneate to truncate at base, with over 18 teeth on each margin. . . . . 3a. *V. pubescens* var. *pubescens*
1. Foliage glabrous or nearly so; stems usually 2-several; basal leaves

1–3; cauline leaves acute at apex, cordate at base, with up to 18 teeth on each margin .... 3b. *V. pubescens* var. *scabriuscula*

3a. *V. pubescens* Aiton var. *pubescens*, Hort. Kew 3:290. 1789; Figs. 1 and 9.

V. pensylvanica Michx., Fl. Bor. Amer. 2:149. 1803.

V. pubescens var. *eriocarpa* Nutt., Genera N. Amer. Plants 1:150. 1818.

V. pubescens var. *peckii* House, Bull. New York State Mus. Nat. Hist. 243–244:50. 1923.

V. pubescens var. *pubescens* f. *peckii* (House) Lévesque & Dans., Naturaliste Canad. 93:515. 1966.

COMMON NAME: Downy yellow violet

HABITATS: Oak and mixed hardwood forests in sandy soils, best represented in the southern Lower Peninsula.

COMMENTS: Plants of this variety and the next sometimes produce first-year basal leaves without aerial stems. In herbaria these leaves are invariably misidentified as sterile *V. sororia* but are recognizable by their yellowish, naked rhizomes with distinct internodes, and essentially entire stipules. As in var. *scabriuscula* below, plants with pubescent ovaries and capsules and glabrous ovaries and capsules are distributed across Michigan, with fruit and foliage pubescence being largely uncorrelated (Voss 1985).

Approximately 5% of all herbarium specimens could not be assigned to var. *pubescens* or var. *scabriuscula* as delimited here because they were roughly intermediate between the extremes. Twice as many additional specimens could be assigned to one variety only through the "majority rule" of suites of characters. For this reason, two morphologically and ecologically intergrading varieties are treated here rather than two species, as Cain (1967) and Lévesque and Dansereau (1966) have done.

Canne (1987) and Clausen (1929) have reported $2n = 12$ chromosomes in this taxon.

3b. *V. pubescens* var. *scabriuscula* Schwein. *ex* T. & G., Fl. N. Amer. 1:142. 1838; Fig. 10.

V. eriocarpa Schwein., Amer. J. Sci. 5:75. 1822.

V. eriocarpa var. *leiocarpa* Fernald & Wiegand, Rhodora 23:275. 1921.

V. pubescens var. *scabriuscula* f. *leiocarpa* (Fernald & Wiegand) Farw., Pap. Michigan Acad. Sci. 2:33. 1923.

V. eriocarpa f. *leiocarpa* (Fernald & Wiegand) Deam, Fl. Indiana: 691. 1940.

V. pensylvanica var. *leiocarpa* (Fernald & Wiegand) Fernald, Rhodora 43:617. 1941.

V. pubescens var. *eriocarpa* (Schwein.) N. H. Russell *non* Nutt., Sida 2:78. 1965.

COMMON NAME: Smooth yellow violet

HABITATS: Mesic sugar maple forests, less often in dry-mesic and swamp or floodplain forests.

COMMENTS: As in var. *pubescens*, the ovaries and capsules may be hairy

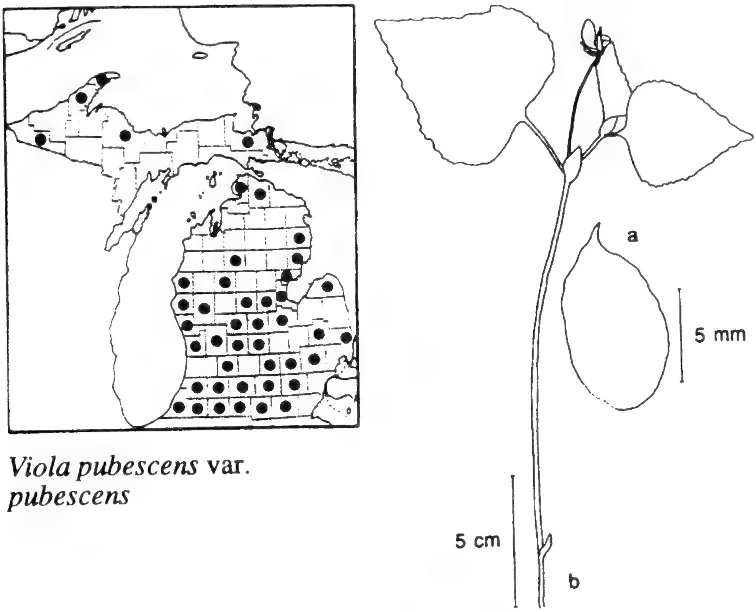


FIGURE 9. *Viola pubescens* var. *pubescens*: Michigan distribution, (a) upper cauline stipule and (b) spring habit.

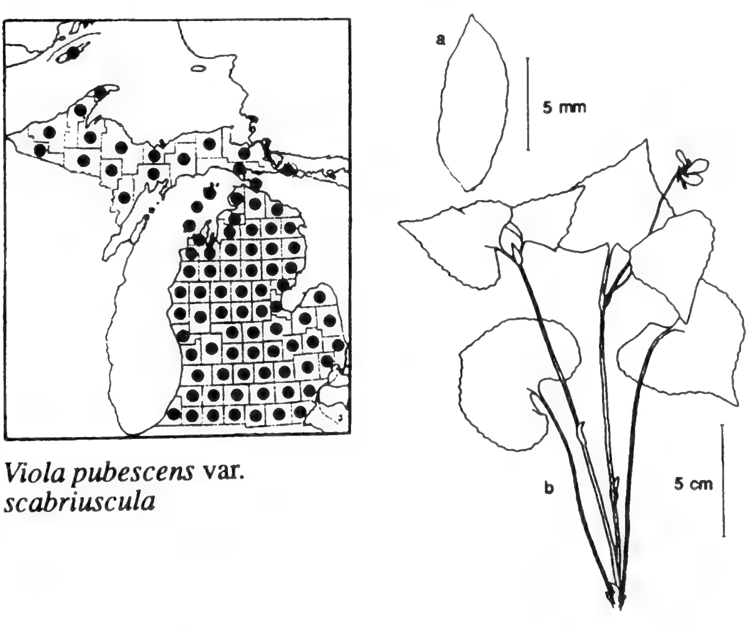


FIGURE 10. *Viola pubescens* var. *scabriuscula*: Michigan distribution, (a) upper cauline stipule and (b) spring habit.

or glabrous. Pringle (1969) sorted out the confused taxonomy of the smooth yellow violet at the varietal level, pointing out that the earliest legitimate name available under *V. pubescens* is var. *scabriuscula* Torr. & A. Gray. Syntypes of this name at the New York Botanical Garden support his conclusion. Such nomenclatural confusion does not affect those who wish to recognize our glabrate variety as a distinct species from var. *pubescens*; in this case the earliest available name is *V. eriocarpa* Schwein. (not *V. pensylvanica* Michx. as frequently seen in popular wildflower guides and manuals, the type material of which is the glabrous-fruited morph of *V. pubescens* var. *pubescens* [Jones 1959]).

Canne (1987) and Clausen (1929) have counted $2n = 12$ chromosomes in this taxon.

MELANIUM GROUP

4. *V. arvensis* Murray, Prodr. Stirp. Goetting:73. 1770; Fig. 11.
COMMON NAME: Field pansy
TOTAL RANGE: Eurasian, reported as a persistent escape or regular introduction from Massachusetts and Nova Scotia west to British Columbia and Minnesota, south to Georgia, Mississippi, and Nebraska; likely to be in most of the eastern United States and adjacent Canada.
HABITATS: Fields, roadsides.
COMMENTS: The present species is very inconspicuous (not at all showy like the next one), and occurs in "weedy" situations that are neglected by most naturalists. Deam (1940) noted its transient nature in a Lagrange County, Indiana clover field. It undoubtedly occurs in every county of the southern Lower Peninsula, and appears to be well established and widely distributed.

Specimens from Antrim, Emmet, Grand Traverse and Van Buren Counties possess floral features somewhat intermediate between this and the next species and may be hybrids.

Clausen (1929) has reported $2n = 34$ chromosomes.

5. *V. tricolor* L., Sp. Pl.:935. 1753; Fig. 12.
COMMON NAMES: Johnny-jump-up, pansy, heartsease, lady's-delight
TOTAL RANGE: No range is provided by Fernald (1950), Gleason and Cronquist (1991), or Russell (1965); Eurasian, possibly not persisting long as an escape in its reported localities from Nova Scotia west to British Columbia (Scoggan 1979) in Canada, and Illinois (Mohlenbrock 1978); probably sporadic throughout the northeastern states and adjacent Canada.
HABITATS: Old dumpsites, abandoned gardens, roadsides.
COMMENTS: Not as widely distributed or as locally common where found as *V. arvensis*, and more frequently encountered in the northern counties of the state.

The few Michigan collections of the garden pansy, *V.* ×*wittrockiana* Gams—questionable as an established escape outside of cultivation—are included here for the sake of convenience. That taxon differs from *V.*

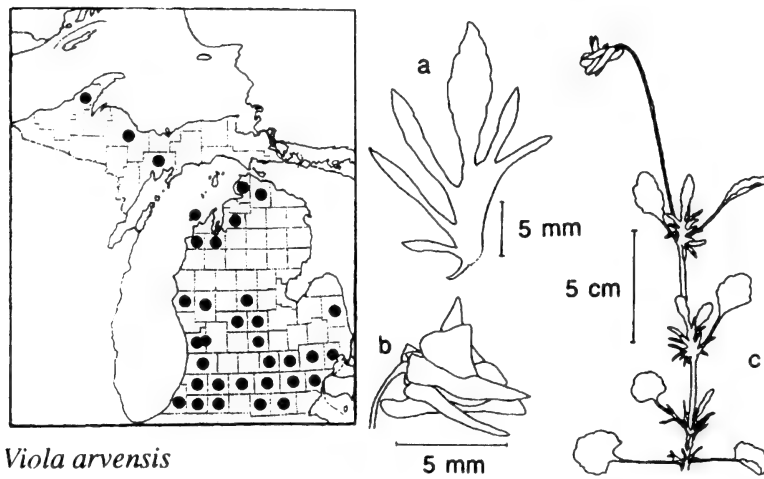


FIGURE 11. *Viola arvensis*: Michigan distribution, (a) upper cauline stipule, (b) profile of flower, and (c) spring habit.

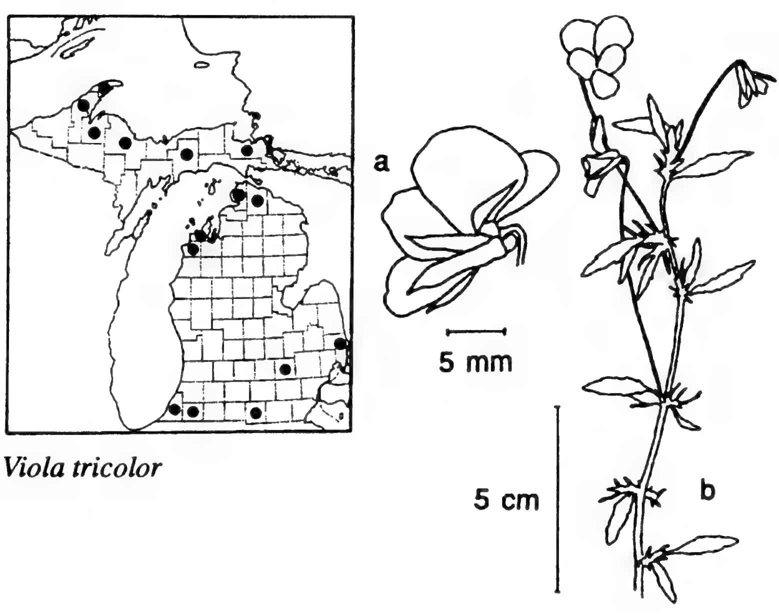


FIGURE 12. *Viola tricolor*: Michigan distribution, (a) profile of flower and (b) spring habit.

tricolor in having larger, more brilliantly and variably colored petals, with the upper tending to be conspicuously larger than the lateral ones. The apparently complex parentage of *V.* ×*wittrockiana* reportedly involves *V. tricolor* and possibly several other European members of the group (Gleason & Cronquist 1991, Shinners 1958).

Clausen (1929) has presented the diploid number of $2n=26$ for this species.

VIOLA GROUP

6. *V. adunca* Sm.; Fig. 13.

KEY TO FORMS

1. Foliage densely short-pubescent . . . . .f. *adunca*
1. Foliage glabrous . . . . .f. *glabra*

6a. *V. adunca* Sm. f. *adunca*, Rees' Cyclopedia: 37, no. 63. 1817.

V. adunca f. *albiflora* Vict. & J. Rousseau, Contr. Inst. Bot. Univ. Montréal 36:20. 1940.

COMMON NAMES: Sand violet, hooked violet

TOTAL RANGE: Nova Scotia and Maine west to Alaska and the Yukon, south to Massachusetts, South Dakota, New Mexico, and California.

HABITATS: Oak or pine forests and dunes in dry sand; rock exposures.

COMMENTS: The species is typically smaller in stature (especially in exposed rocky sites) than others in the group, and is the only one in our region with foliage that is commonly densely covered with short hairs. It possesses a dark purple corolla and dark blue-green foliage in contrast to the pale blue corolla and yellow-green foliage of *V. labradorica*, with which it hybridizes wherever the two are sympatric.

McPherson and Packer (1974) have reported diploids with $2n=20$ chromosomes throughout the range of the species, and tetraploids as well as triploid hybrids from the Pacific Northwest eastward to the northwest shore of Lake Superior. Our populations are presumably mainly, if not entirely, diploid, although tetraploids would be expected on Isle Royale. On weak morphological grounds that predominantly reflect larger size of pollen grains and guard cells in polyploids, and on genetic isolation of diploids and tetraploids, McPherson and Packer argued for species rank of the tetraploids, for which Löve and Löve (1975) have provided the name *V. aduncoides*.

6b. *V. adunca* f. *glabra* (Brainerd) G. N. Jones, Univ. Wash. Publ. Biol. 5:194. 1936.

V. adunca var. *glabra* Brainerd, Rhodora 15:109. 1913.

COMMON NAMES: Sand violet, hooked violet

TOTAL RANGE: Same as the typical form, more frequent northward, occurring with equal frequency in western North America.

HABITATS: Generally the same as the typical form, with a tendency toward open rock sites.

COMMENTS: Identical to the typical form, except that foliage is nearly or completely glabrous. Specimens of f. *glabra* have been seen from Baraga, Kent, Keweenaw, and Otsego Counties as well as Isle Royale.

Taxonomists recognizing *V. adunca* var. *minor* (Hooker) Fern. have traditionally merged *V. adunca* f. *glabra* with northern populations previously segregated from *V. conspersa* Reichenb. as *V. labradorica* Schrank. This confusion is elaborated below, and addressed in detail by Ballard (1992).

7. *V. labradorica* Schrank, Densch. Bot. Gesell. Regensb. 2:12. 1818; Fig. 14.

V. conspersa Reichenb., Plantae Criticae 1:44. 1823.

V. adunca var. *minor* (Hook.) Fernald, Rhodora 51:57. 1949.

COMMON NAME: Labrador violet, American dog violet

TOTAL RANGE: Indigenous to Nova Scotia and Maine west to Manitoba, south to New Jersey, western South Carolina, Alabama, northeastern Illinois, and southeastern North Dakota.

HABITATS: Mesic sugar maple forests and swamps in muck or peat, less often in sandy floodplains, moist rock exposures, and riverbanks.

COMMENTS: Foliage in living plants is nearly or quite glabrous and light green, in contrast to the darker blue-green foliage and dense, minute hairs of *V. adunca* f. *adunca*. Plants average smaller than most other members of its group and bear pale flowers, and are consequently easily overlooked in the field. As with other native members of this group, the stems in *V. labradorica* recline conspicuously in summer and autumn.

Brainerd (1921) and Russell (1959, 1965) maintained *V. labradorica* Schrank as a distinct species, considering it the northern, smaller counterpart of *V. conspersa*. They distinguished the former by its smaller size, more compact habit, undissected stipules, and boreal distribution. Fernald (1950), Gleason and Cronquist (1991), Scoggan (1979), and others recognized these northern populations as *V. adunca* var. *minor* (Hook.) Fernald, rather than *V. labradorica* Schrank, and included under this combination the glabrous morphs of *V. adunca*, thus blurring the taxonomic limits of *V. adunca* and *V. labradorica sensu lato*.

Studies of the *V. adunca-conspersa-labradorica* complex (Ballard 1992) have revealed that pubescent and glabrous forms comprising *V. adunca* are morphologically very distinct in distribution of pubescence and in other floral and vegetative features from the *V. conspersa-labradorica* complex. The southern and northern populations of the latter complex (*V. conspersa s. str.* and *V. labradorica s. str*, respectively) were morphologically distinguishable on the basis of subtle leaf shape criteria, and only at the northern and southern endpoints of the range of the complex. Specimens from a broad belt across the middle of the composite range, e.g. along the United States-Canadian border, could not be assigned confidently to either taxon. A single polymorphic species was accepted, using the earliest available name. Ironically, the basionym of *V. adunca* var. *minor*, which many have since applied to boreal populations, proved upon type studies to be based on *V. muhlenbergiana* Ging. var. *minor* Hooker, which in turn is based on *V. debilis* Pursh *non* Michx., a name for a Pennsylvania specimen and

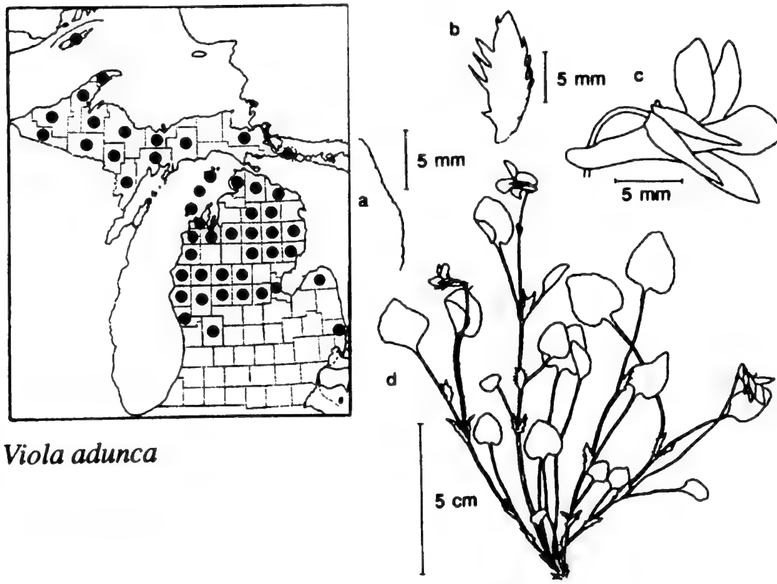


FIGURE 13. *Viola adunca*: Michigan distribution, (a) cauline leaf margin, (b) upper cauline stipule, (c) profile of flower, and (d) spring habit.

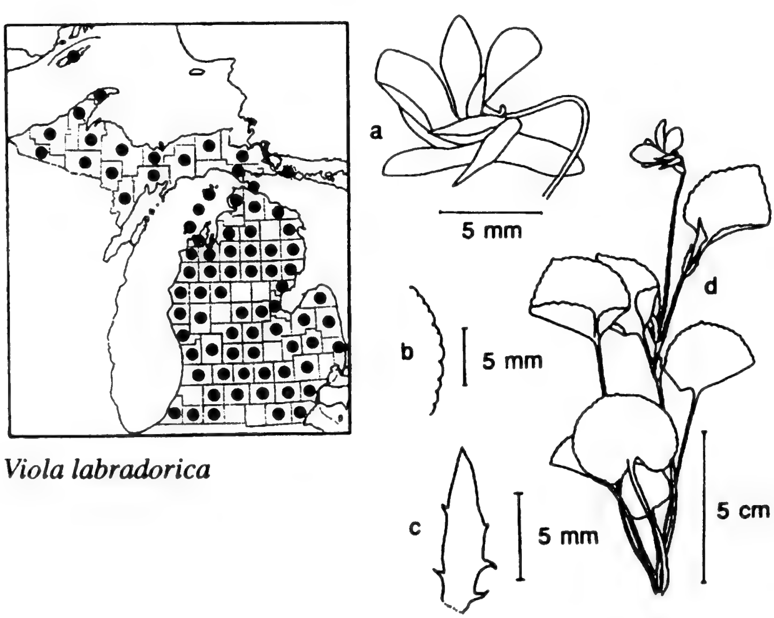


FIGURE 14. *Viola labradorica*: Michigan distribution, (a) profile of flower, (b) cauline leaf margin, (c) upper cauline stipule, and (d) spring habit.

therefore not applicable to the boreal populations. Aside from nomenclatural or taxonomic issues, all Michigan specimens labelled by others as *V. labradorica s. str.* have turned out to be *V. adunca* f. *glabra* or *V. adunca* × *conspersa*.

Farwell's (1917a) *V. conspersa* var. *masonii* Farwell, a name intended for white-flowered *V. conspersa*, is based on a specimen of typical *V. striata* collected near Utica (*Farwell 4163*, 6/6/1916, BLH, MCTF, MICH). Consequently, the new combinations based on Farwell's variety by House and Boivin are synonyms of *V. striata* Aiton.

In the southern Lower Peninsula, this species blooms earlier than *V. rostrata* and *V. striata* and begins setting fruit as the latter two come into full flower (Ballard 1990b). It hybridizes occasionally with *V. adunca*, and frequently with *V. rostrata* and *V. striata* (Ballard 1990a, 1990b).

Canne (1987) and Clausen (1929) have reported $2n = 20$ chromosomes in the species (as *V. conspersa*).

8. *V. odorata* L., Sp. Pl.:934. 1753; Fig. 15.
COMMON NAMES: English violet, sweet violet
TOTAL RANGE: Eurasian, recorded as a persistent escape from scattered locations from Nova Scotia and Massachusetts south to Georgia and west to British Columbia, California and Arizona; certainly under-collected in our state and elsewhere.
HABITATS: Lawns, fencerows and suburban woodlots.
COMMENTS: This tenacious naturalized species from Europe is easily separable in flower from *V. sororia* and other stemless violets by the sharp conic-recurved hook at the apex of the style; and, in fruit, by the green cordlike stolons (distinguishing it from *V. sororia* and other stemless blue violets), regularly crenate margins, densely short-pubescent leaves and purple-flecked, pubescent capsules (setting it apart from *V. blanda* and related stoloniform violets). Voss (1985) noted the rugose texture of upper leaf surfaces; this is a useful field character. Its seeds are larger than all our other violets except *Hybanthus*.

Corollas are white or blue, with colonies of either morph distributed seemingly at random across a given site and frequently producing colonies of apparent intermediates.

Clausen (1929) has counted $2n = 20$ chromosomes in the species.

9. *V. rostrata* Pursh, Fl. Amer. Sept. 1:174. 1814; Fig. 16.
V. rostrata var. *elongata* Farw., Rep. Michigan Acad. Sci. 19:249. 1917.
COMMON NAME: Long-spurred violet
TOTAL RANGE: Indigenous to Quebec and New Hampshire west to southwestern Ontario, south to North Carolina, Georgia, Indiana, and eastern Wisconsin; also known from Japan (Harvey 1966).
HABITATS: Oak forests in dry sandy loam, and less often in drier microsites in mesic sugar maple or floodplain forests, in slightly acidic to circumneutral soils.
COMMENTS: The long spur (which inspired both scientific and common

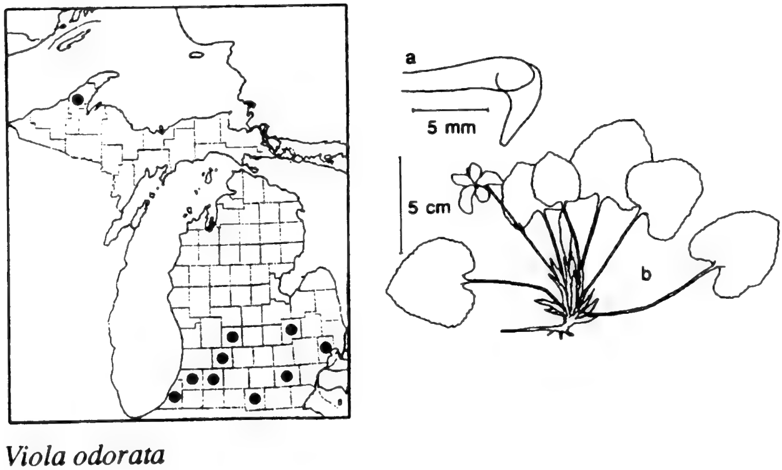


FIGURE 15. *Viola odorata*: Michigan distribution, (a) stigma, and (b) spring habit.

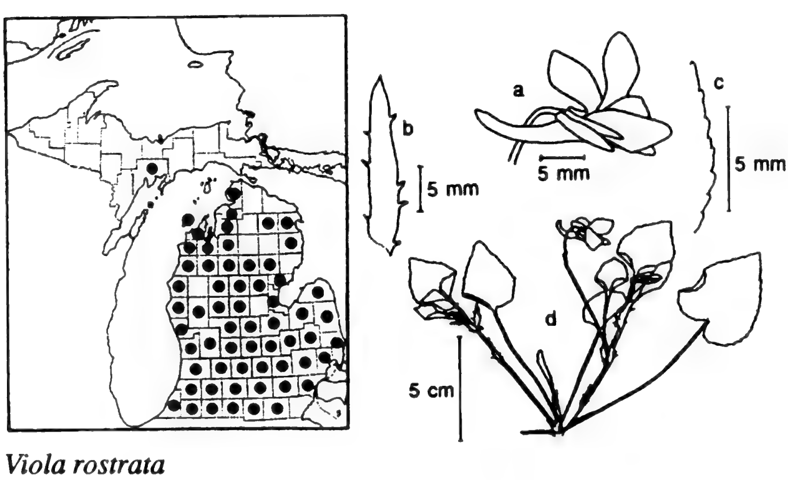


FIGURE 16. *Viola rostrata*: Michigan distribution, (a) profile of flower, (b) upper cauline stipule, (c) cauline leaf margin, and (d) spring habit.

names) and lavender corolla of this species might suggest flowering *V. adunca*, but the absence of beards on the lateral petals would distinguish it from the latter; in fruit, its nearly glabrous, remotely serrate, deeply cordate leaves differ from the often densely short-pubescent, closely crenate to subentire, truncate leaves of *V. adunca* and also express themselves in interspecific hybrids.

The species hybridizes commonly with *V. conspersa* and *V. striata*, and shows a phenological peak between that of the former and that of the latter (Ballard 1990b). While it often grows near these species in more mesic or wet situations, and frequently hybridizes where proximity and habitat conditions permit, it characteristically inhabits drier microsites.

Farwell's (1917a) var. *elongata*, based on a specimen he collected near Utica in Macomb County (*O. A. Farwell 4166*, 6/16/1916) but not located during herbarium searches, is a longspurred populational extreme undeserving of taxonomic recognition. Farwell (1930) reported a white-flowered plant, as var. *phelpsiae* (Fernald) Farw., from near Farmington in Oakland County. I have seen this white morph near the Black River in northern St. Clair County.

Canne (1987) and Clausen (1929) have reported $2n = 20$ chromosomes in the eastern North American populations.

10. *V. striata* Aiton, Hort. Kew 3:290. 1789; Fig. 17.

V. conspersa Reichenb. var. *masonii* Farw., Rep. Michigan Acad. Sci. 19:248. 1917.

V. conspersa f. *masonii* (Farw.) House, Bull. New York St. Mus. Nat. Hist. 254:511. 1924.

V. striata f. *albiflora* Farw., Amer. Midl. Naturalist 11:67. 1928.

COMMON NAMES: Cream violet, striped violet, pale violet

TOTAL RANGE: Indigenous to Massachusetts and southern Ontario west to southern Wisconsin, south to South Carolina and Arkansas.

HABITATS: Floodplains in silty loam; often spreading aggressively along natural drainages or footpaths.

COMMENTS: This species is often mistaken for *V. canadensis* in flower, owing to its cream-white corolla, but can be distinguished at a glance in lacking the yellow center of the corolla of *V. canadensis*; in fruit, it can be distinguished from the latter by its herbaceous, strongly fringed stipules.

Its cream-white corolla and shorter spur seem at first glance to set it apart from other purple-flowered, long-spurred members of the group. However, similar morphological features, common hybridization with other species, and the same number of chromosomes demonstrate its proper membership in the Viola group. Plants are frequently encountered with all five petals heavily bearded by threadlike hairs within, a feature virtually unknown in other members of the group. Plants typically bear a sparse covering of stiff, flattened, sharp-pointed hairs on the upper surface of the leaf blades, particularly near the basal lobes. Very rarely, this indument is more noticeable and extensive. It is biogeographically intriguing to note that several southeastern Asian violets of the *Viola acuminata* complex in the Viola group are identical in growth habit, diagnostic foliage and floral features, and floodplain habitat with our *V. striata*, except that they lack basal leaves, bear a denser covering of hairs on the foliage, and have corollas that vary from blue to cream-white.

Farwell (1928) published the trivial name f. *albiflora* Farw. for a Michigan specimen that lacked the typical purple-black nectar guides on the inside of the spur petal blade. The name *V. striata* var. *lutescens* Wood *ex* Coleman was published for an indistinct color variant of this species, but no type specimen was cited. All specimens formerly at the Kent Scientific Institute, which later became the Grand Rapids Public Museum, have been deposited at MICH, but no specimens attributable to Coleman have ever been located (Voss 1985).

Clausen (1929) has presented the diploid chromosome number as $2n=20$.

11. *V. adunca* × *labradorica*

TOTAL RANGE: Vermont (Brainerd 1924), Ontario (Brainerd 1924, McPherson & Packer 1974), Michigan and Wisconsin; expected throughout the common range of the parent species.

COMMENTS: Intermediate between the two parents, and larger and more vigorous with many more erect stems than either species. The greener, more

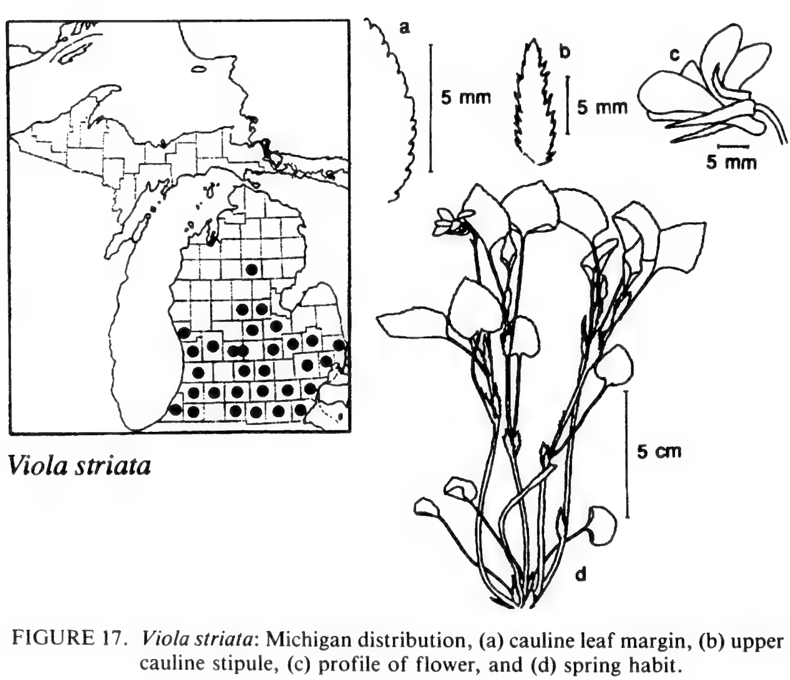


FIGURE 17. *Viola striata*: Michigan distribution, (a) cauline leaf margin, (b) upper cauline stipule, (c) profile of flower, and (d) spring habit.

sparsely short-pubescent foliage and relatively shorter spur (albeit larger flowers) would distinguish it from *V. adunca*, while the more strongly triangular, truncate leaves with scattered pubescence would set it apart from nearby *V. labradorica*. Like other hybrids in the Viola group, it does not produce well-developed cleistogamous capsules and seeds, and is thus entirely sterile (Ballard 1992).

Russell's statement (1965) that *V. adunca* and *V. labradorica* (as *V. conspersa*) do not often grow in proximity notwithstanding, I have found many situations in northern Michigan where the two species grow near one another. In such situations, one may well expect hybridization to take place. Additional field studies are needed across the sympatric range of the parent species to determine the extent of hybridization between them.

In Michigan, this hybrid is documented from St. Clair, Alpena, Charlevoix, Mackinac, and mainland Keweenaw Counties, as well as Isle Royale and Mackinac Island.

12. *V. ×brauniae* Grover *ex* Cooperr., Michigan Bot. 25:108–109. 1986.
V. rostrata × striata

TOTAL RANGE: So far known from Indiana, Kentucky, Michigan, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Ontario (Ballard 1990b, 1993); probably occurs throughout the common range of its parent species.

HABITATS: Ecotonal areas bordering swamps and floodplains where the parent species co-occur.

COMMENTS: This hybrid is quite robust (often with more erect stems), and combines the morphological features of *V. rostrata* and *V. striata*, as described by Cooperrider (1986). It is easily recognizable in the field by its pale lavender corolla with dark purple eyespot, bearded lateral petals, and sparsely ciliate, acuminate sepals with well-developed auricles. In older herbarium specimens that fail to show corolla color patterns, the leaves have acuminate apices and irregularly crenulate margins, and stipules are lance-ovate and strongly lacerate. It is often misidentified as *V. rostrata* owing to its pronounced spur and dark purple eyespot.

In Michigan, this hybrid is known from Berrien, Branch, Cass, Kalamazoo, Kent, Lenawee, Saginaw, and St. Clair Counties.

13. *V. ×eclipes* H. E. Ballard, Michigan Bot. 28:217. 1990 ["1989"].
V. labradorica × striata

TOTAL RANGE: Thus far documented from Indiana, Illinois, Maryland, Massachusetts, Michigan, New York, Ohio, Pennsylvania, Rhode Island, Tennessee, West Virginia, and Ontario (Ballard 1990a, 1990b, 1993), and expected throughout the sympatric range of its parents.

HABITATS: Ecotonal areas along swamps and floodplains, where the parent species intermingle.

COMMENTS: Unique in its watery, pale blue corolla with large white center, and otherwise distinctive in possessing sparsely ciliate sepals, well-developed auricles, irregularly crenulate, abruptly acute leaves, and heavily fringed stipules. The unusual corolla color, ciliate sepals and subacuminate, crenulate leaves separate it from *V. labradorica*, with which it is most often confused.

It has been collected in Berrien, Cass, Huron, Ingham, Lapeer, Lenawee, Midland, Monroe, St. Clair, Washtenaw, and Wayne Counties in Michigan.

14. *V.* ×*malteana* House, Bull. New York State Mus. Nat. Hist. 254:511. 1924.

V. conspersa × *rostrata*.

TOTAL RANGE: Known from Ontario, Michigan, Ohio, Pennsylvania, Vermont, and New Jersey (Ballard 1990b, 1993); probably occurs throughout the common range of its parents.

HABITATS: Ecotonal areas bordering swamps where the parent species grow in proximity.

COMMENTS: This hybrid possesses features intermediate between *V. conspersa* and *V. rostrata*; it is most distinctive in its long spur, light purple corolla with darker purple eyespot, bearded lateral petals, and eciliate sepals.

Like other hybrids in the group, it produces no mature cleistogamous capsules or seeds. Malte and Macoun (1915) first recognized its existence in specimens from Ontario, noting the intermediate morphology and abortive pollen of the hybrid. Plants in the field do not show the larger overall size and more erect stems characteristic of *V.* ×*brauniae* and *V.* ×*eclipes*. Rather, the habit appears more truly intermediate between the moderately ascending stems of *V. conspersa* and the gradually or weakly ascending ones of *V. rostrata*. Specimens are nearly always misidentified in herbaria as *V. conspersa*, but may be distinguished by the unusually longer spur, conspicuous purple-black eyespot near the corolla throat, longer stipules, and remotely serrate leaves tending to become subacuminate.

The hybrid is thus far confirmed in Michigan from Charlevoix, Cheboygan, Clare, Huron, Isabella, Kalamazoo, Midland, Oakland, Osceola, Tuscola, Van Buren, and Wayne Counties.

PLAGIOSTIGMA GROUP

15. *V. blanda* Willd., Hort. Berol.:t.24. 1804; Fig. 18.

V. incognita Brainerd, Rhodora 7:248. 1905.

V. incognita var. *forbesii* Brainerd, Bull. Torrey Bot. Club 38:8. 1911.

COMMON NAMES: Sweet white violet, white snowdrops, mayflower, large-leaved white violet

TOTAL RANGE: Nova Scotia and Maine west to Ontario and North Dakota, south to New Jersey, western North Carolina, eastern Tennessee, northern Indiana, and eastern Iowa.

HABITATS: Low moist to wet areas of oak and mixed hardwood forests, bog forests, and on hummocks in swamps and open bogs.

COMMENTS: Stolons are present even on very young plants, separating this species immediately from *V. renifolia*, with which it often grows intermingled. It always has some hairs on the leaf blade, albeit sparse in some specimens, thus easily separating it from *V. macloskeyi* with strictly glabrous leaf blades. Pubescence patterns in *V. incognita* and *V. renifolia* have been described in detail by Russell (1954b, 1955a).

Our representative of this widespread northeastern species has customarily been segregated from *V. blanda* Willd. as *V. incognita* Brainerd, with the former name reserved in the strict sense for glabrate Appalachian populations. A greater amount of morphological variability has been found in living and herbarium specimens across the reported range of the complex than published literature admits, and considerable overlap exists in all characters said to distinguish the two species. The taxonomic resolution of this complex requires additional study, including extensive statistical analyses. In the absence of compelling evidence for the recognition of two taxa, all populations of the complex are treated as a single polymorphic species.

Clausen (1929) reported $2n=48$ chromosomes, but Gershoy (1934) and Canne (1987) later found the aneuploid number $2n=44$; in a later cytogenetic review, Clausen (1964) accepted the aneuploid counts as correct.

16. *V. epipsila* Ledeb., Ind. Sem. Hort. Dorpat.:5. 1820; Fig. 19.
COMMON NAME: Northern marsh violet
TOTAL RANGE: Circumboreal; currently known from Ontario and Michigan (Ballard 1985) west to Alaska and Eurasia, south to the Rocky Mountains of Colorado, Arizona, and California; possibly ranging further east in Canada than currently known.
HABITATS: Alder swamps and black spruce muskegs.
COMMENTS: Distinctive among all the stemless violets when flowering, in its blue corollas and stolons; in fruit, distinguished from *V. blanda* in having green cleistogamous capsules on erect peduncles; and completely glabrous leaf blades, thus resembling *V. macloskeyi*, but differing in the serrate leaf margins and gray-black seeds. In addition, *V. epipsila* (and the more eastern and western *V. palustris*) has more conspicuously creeping rhizomes with distinct internodes, resulting in leaves that are displaced from one another along the rhizome rather than appearing in a basal rosette as in *V. macloskeyi*. This boreal violet is represented in our region by ssp. *repens* (Turcz.) Becker.

In his cytotaxonomic review of the Palustres complex, Sorsa (1968) has continued the action of previous taxonomists in maintaining *V. epipsila*, a diploid with $2n=24$ chromosomes, and tetraploid *V. palustris* as distinct species each with infraspecific taxa. Gleason and Cronquist (1991), however, merged them under the latter. Morphological separation, at least in North America, is not satisfactory and requires further study—ideally across the circumboreal range of the complex.

Our single Michigan station on Manitou Island off the coast of the Keweenaw Peninsula, the first record for eastern North America, is based on a sheet at BLH that was inexplicably misidentified as *V. incognita* by Russell (Ballard 1985). Given its rarity, this species is listed as "state-threatened" in Michigan.

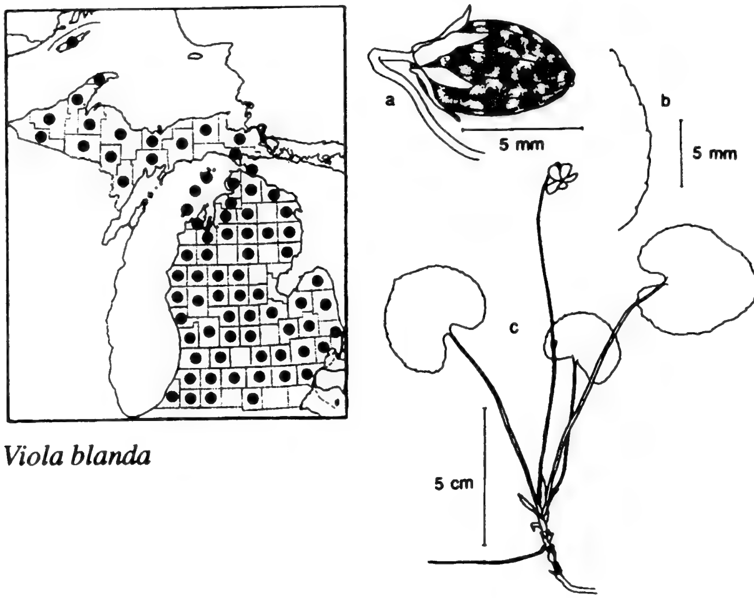


FIGURE 18. *Viola blanda*: Michigan distribution, (a) cleistogamous capsule, (b) leaf margin, and (c) spring habit.

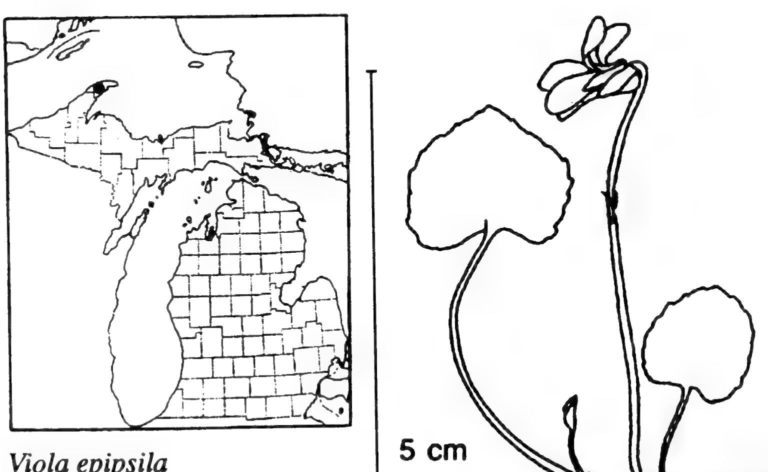


FIGURE 19. *Viola epipsila*: Michigan distribution and spring habit.

17. *V. lanceolata* L., Sp. Pl.:934. 1753; Fig. 20.
COMMON NAMES: Lance-leaved violet, water violet
TOTAL RANGE: Nova Scotia and Maine west to Ontario and Minnesota, south to South Carolina, Alabama, and Texas.
HABITATS: Sedge meadows and open bogs, in open sand or sandy peat.
COMMENTS: Immediately recognizable among all stemless violets by its lanceolate leaves. Some summer and fall specimens develop broader leaves that taper more abruptly at the base, resembling *V.* ×*primulifolia* superficially, but they are not definitely truncate at the base as in that species. Like *V. macloskeyi*, a very close relative, it produces stolons a short time after flowering; its capsules and seeds are also similar to those of *V. macloskeyi*.

All our specimens are representative of var. *lanceolata*, distinguished by lanceolate leaf blades rather than the linear ones of primarily coastal plain var. *vittata* (Greene) Weatherby & Griscom. The latter variety was mapped by Russell (1965) from a few counties at the southern end of Lake Michigan, but herbarium specimens I have seen do not quite match the extreme leaf shape observed in specimens collected from the Atlantic and Gulf coastal plains, nor have Swink and Wilhelm (1979) been convinced of the presence of typical var. *vittata* in this region.

Canne (1987) and Clausen (1929) have reported $2n = 24$ chromosomes in the species.

18. *V. macloskeyi* F. E. Lloyd, Erythea 3:74. 1895; Fig. 21.
V. pallens (Banks *ex* DC.) Brainerd, Rhodora 7:247. 1905.
V. macloskeyi ssp. *pallens* (Banks *ex* DC.) M. S. Baker, Madroño 12:60. 1953.
COMMON NAMES: Northern white violet, smooth white violet, woodland white violet
TOTAL RANGE: Nova Scotia and Maine west to Manitoba and Minnesota, south to Rhode Island, northeastern Alabama, eastern Tennessee, central Ohio, and northern Indiana; disjunct in southeastern Iowa and eastern Missouri.
HABITATS: Marshes, sedge meadows, and open bogs; small depressions in swamps.
COMMENTS: Often confused (nearly as often by specialists as by lay naturalists) with *V. blanda*, but differing in its completely glabrous leaf blades with crenate to subentire margins, and green cleistogamous capsules with black seeds. As Voss (1985) points out, this is our smallest violet.

Most specialists and taxonomists have traditionally split this violet into two species, subspecies, or varieties distinguished by overall size, subtle differences in leaf shape, and leaf margin. A morphometric study in progress suggests that two subspecies can indeed be reliably distinguished based on overall leaf blade shape and depth of marginal teeth, one representing the essentially Californian ssp. *macloskeyi* and the other the widespread ssp. *pallens*, including Great Lakes populations.

It is often found growing within a few feet of (or even intermingled with) *V. blanda* and *V. renifolia*, and among *V. cucullata* or *V. nephrophylla* in

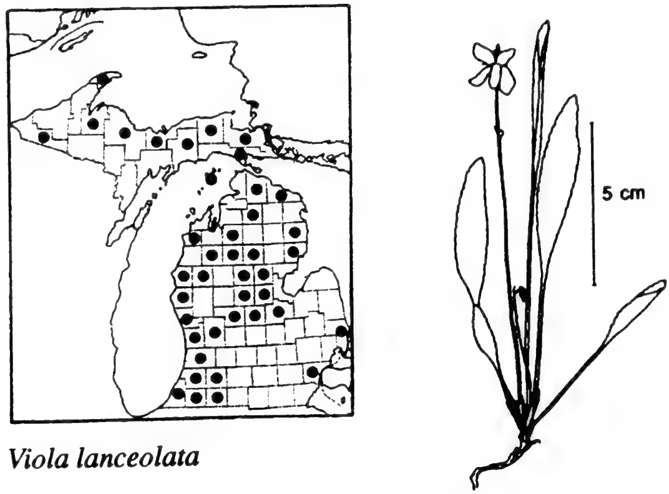


FIGURE 20. *Viola lanceolata*: Michigan distribution and spring habit.

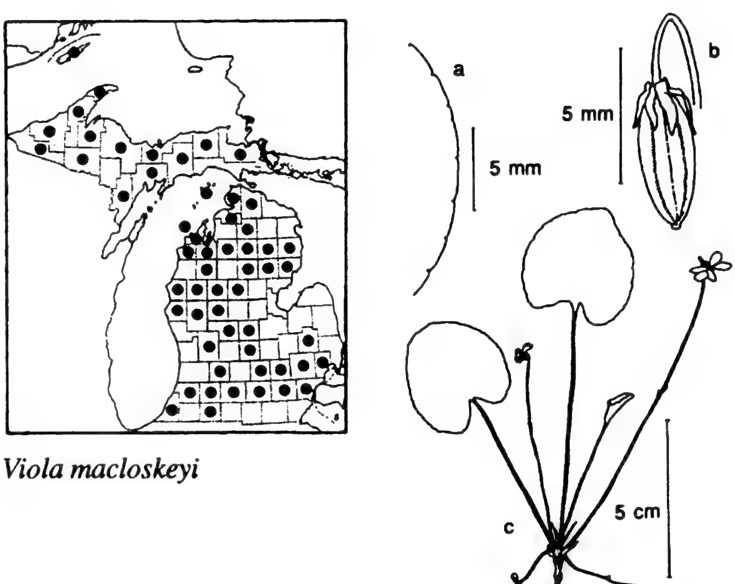


FIGURE 21. *Viola macloskeyi*: Michigan distribution, (a) leaf margin, (b) cleistogamous capsule, and (c) spring habit.

some wetlands. The species is known to hybridize with *V. blanda* and *V. renifolia*, with hybrids most frequently found along roads cutting through or adjacent to bog forests and in ecotones separating northern sedge meadows and swamp forests.

Canne (1987) and Clausen (1929) have presented a chromosome number of $2n = 24$ for this species.

19. *V. renifolia* A. Gray, Proc. Amer. Acad. Arts 8:288. 1870; Fig. 22.

V. mistassinica Greene, Pittonia 4:5. 1899.

V. brainerdii Greene, Pittonia 5:89. 1902.

V. renifolia A. Gray var. *brainerdii* (Greene) Fern., Rhodora 14:88. 1912.

COMMON NAME: Kidney-leaved violet

TOTAL RANGE: Nova Scotia and Maine west to Yukon and Alaska, south to Massachusetts, central Michigan, and central Wisconsin.

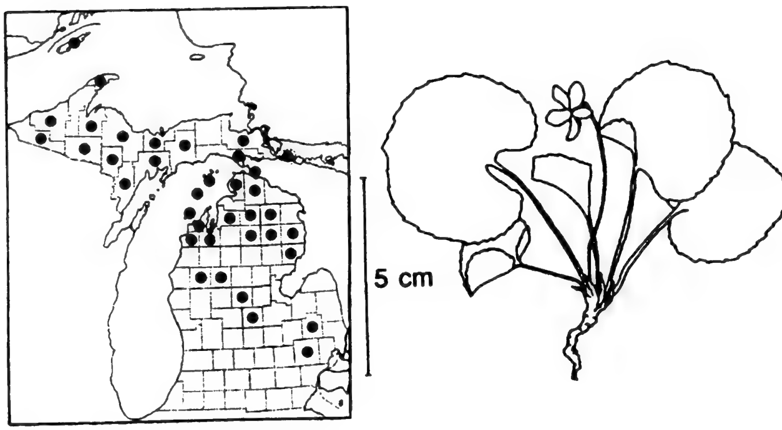
HABITATS: Conifer (especially white cedar) swamps, hummocks in bog forests and open bogs, in dry to mesic peat; also in thin soil of rock crevices.

COMMENTS: This species is similar to *V. blanda* overall, and is often misidentified as that species; hybridization on top of leaf variation certainly confounds accurate identification. It may be most easily distinguished from *V. blanda* by the complete lack of stolons, and its more or less vertical (though sometimes twisted) rhizome. Additional tendencies include very broadly ovate to reniform leaves with truncate apex, midrib usually less than 75% of the blade width, and longer hairs on the foliage (when present). Occasional plants bear orbicular leaves reminiscent of *V. rotundifolia*. The capsules and seeds are generally similar to those of *V. blanda*.

Three discrete classes of pubescence can be consistently distinguished: leaves glabrous and shiny above, and glabrous or pubescent below, often named var. *brainerdii* Greene; leaves silky-pubescent on both sides, representing var. *renifolia*; and a third unnamed kind with leaves pubescent above but glabrous below. The first two types are distributed haphazardly and commonly throughout a given population; the third is very rare. All grow closely intermixed without apparent isolation or microgeographic distributional differences. Because the pubescence morphs do not differ in any other observable way, they are not recognized formally in this treatment.

Thompson (1923) distinguished var. *brainerdii* from the typical form by its rounded summer leaves, narrower sinus 1/3 to 1/4 the length of the leaf blades, and "runners rare". Russell (1955a) also noted runners as a rare occurrence in this species. Examinations of thousands of herbarium specimens and living plants from many Great Lakes populations have failed in revealing stolons on otherwise positively identified *V. renifolia*, but such stolons on specimens with reniform leaves were typical hallmarks of *V. blanda* × *renifolia*.

Russell (1965) maps several Lower Peninsula counties for this species, but the only verified station south of the tension zone is the conifer swamp community around Lakeville Lake in Oakland County. Other reports of



Viola renifolia

FIGURE 22. *Viola renifolia*: Michigan distribution and spring habit.

this species in the southern half of the Lower Peninsula are referable to misidentified *V. blanda*.

Canne (1987) and Clausen (1929) have counted $2n = 24$ chromosomes in *V. renifolia*.

20. *V. blanda* × *lanceolata*

TOTAL RANGE: To be expected rarely across the common range of the parent species.

HABITATS: The single collection was made on the edge of a wet meadow near shrub carr.

COMMENTS: Intermediate in morphology between its parent species, similar to *V. primulifolia* in overall leaf shape but blades definitely broader and subcordate to cordate at the base; completely sterile (no cleistogamous capsules or seeds produced). The single Gogebic County specimen at the University of Michigan Herbarium represents the first confirmed report of such a cross, and is intermediate in foliage features of the parent species as well as completely sterile. Additional plants on the same sheet may be specimens of this cross or (more likely) *V. primulifolia*, which is known from the same locality. The hybrid should be carefully sought elsewhere over the common range of the two parent species, and studied for further details of morphology and local frequency.

21. *V. blanda* × *macloskeyi*
TOTAL RANGE: To be expected frequently across the common range of the parent species.
HABITATS: Usually among both parent species where they co-occur, usually in bog forests or conifer swamps.
COMMENTS: Intermediate in morphology between the parent species, resembling *V. macloskeyi* in overall leaf shape and more crenulate margin, but with scattered hairs (especially near the margin above and beneath) on the lamina. The pollen is inviable and cleistogamous capsules are abortive.
The hybrid has been documented from Isle Royale, and Chippewa and Gratiot Counties.

22. *V. blanda* × *renifolia*
TOTAL RANGE: To be expected frequently across the common range of the parent species; thus far reported from Michigan, and Minnesota (Russell 1954a).
HABITATS: Found in sites where the species co-occur, such as conifer swamps, bog forests, and ecotones along the lowland forest-swamp continuum.
COMMENTS: Resembles *V. renifolia* in foliage but produces stolons. It is likely much more widespread than currently known, as the parent species are sympatric over a fairly broad range. So many features of flowers, foliage, pubescence pattern, and capsule morphology overlap in the parent species that examinations of pollen viability or cleistogamous seed production should be made for confirmation of hybrid identity.
This hybrid is known from Isle Royale and Cheboygan, Gogebic, Houghton, Marquette and Oakland Counties.

23. *V.* ×*primulifolia* L. (pro sp.), Sp. Pl.:934. 1753; Fig. 23.
V. primulifolia var. *villosa* A. Eaton, Manual, 5th Ed.:443. 1829.
V. primulifolia var. *acuta* (Bigelow) T. & G., Fl. N. Amer. 1:139. 1838.
V. lanceolata × *pallens*
COMMON NAME: Primrose-leaved violet
TOTAL RANGE: (Including all reports of *V.* ×*sublanceolata* and *V. primulifolia*) from Nova Scotia and Maine west to Ontario, south to Florida, Texas, Illinois, and Minnesota.
HABITATS: Sedge meadows and bogs, often in *Sphagnum* and associated with *V. macloskeyi* var. *pallens* or *V. lanceolata*.
COMMENTS: Immediately distinguishable from the cordate-leaved stoloniferous species such as *V. blanda* and *V. macloskeyi* by its lance-ovate leaf blades distinctly longer than wide; and further distinguished from similar *V. lanceolata* in its very broadly tapering or truncate leaf bases. Specimens of *V. lanceolata* producing new leaves in late summer and fall, particularly after environmental stress (prolonged drought followed by inundation), produce slightly broader, more abruptly cuneate-based leaves that might be casually mistaken for this species; they are distinguished from *V. primulifolia* in the cuneate (not subtruncate to subcordate) leaf bases.

The taxon as here delimited includes Coastal Plain *V. primulifolia* as well as *de novo* fertile and subfertile plants derived from local hybridization between *V. lanceolata* var. *lanceolata* and *V. macloskeyi* ssp. *pallens*. Examinations of specimens referred by specialists and taxonomists to "true" *V. primulifolia* L. from the Atlantic Coastal Plain have revealed no consistent morphological or ecological differences, aside from relative fertility in pollen and cleistogamous capsules, to separate Linnaeus' taxon from the hybrid populations called *V.* ×*sublanceolata* House at inland North American localities.

Specialists and taxonomists have long disagreed over the appropriate treatment of our Great Lakes plants. Deam (1940), Fernald (1950), Gleason and Cronquist (1991) and Mohlenbrock (1978) accepted *V. primulifolia* in our region, in most cases specifically for plants of meadows and marshy or swampy ground in northeastern Illinois and northwestern Indiana near the southern end of Lake Michigan. However, Scoggan (1979) followed Boivin (1966) and Cinq-Mars (1966) in excluding most or all Canadian records of *V. primulifolia* as representing *V. lanceolata* × *macloskeyi*. Russell (1955a, 1965) called the Illinois and Indiana material *V. primulifolia* but assigned all populations from farther north and west to the hybrid (Russell 1959). Given the lack of any clear distinctions (besides relative age of populations) between apparent hybrid populations—whether evidently fertile or subfertile—and Coastal Plain populations, all lance-ovate acaulescent white violets are here designated *V.* ×*primulifolia*. Further study of Great Lakes populations is desperately needed, particularly to elucidate the status and possible origin of occasional, ostensibly fertile populations reported from several localities in Michigan (Don Henson, pers. comm., specimens at MICH) and northern Illinois (Gerould Wilhelm, pers. comm.), and to examine and compare the evolutionary history of coastal plain *V. primulifolia*.

Clausen (1929) has reported a chromosome number of $2n=24$ for eastern specimens.

VIOLIDIUM GROUP

24. *V. selkirkii* Pursh *ex* Goldie, Edinburgh Philos. J. 6:324. 1822; Fig. 24.

COMMON NAMES: Great-spurred violet, Selkirk's violet

TOTAL RANGE: Circumboreal, in North America from Nova Scotia and Maine, west to Alaska and the Yukon, south to northeastern Minnesota, central Michigan, and northern Pennsylvania; reported by Russell (1965) as disjunct in southwestern South Dakota.

HABITATS: Conifer or hardwood forests, mostly mesic, in loam; also soil-filled rock crevices.

COMMENTS: The species is distinctive in flower, having an acaulescent habit, purple corolla with glabrous lateral petals, and a well-developed spur. In fruit the species superficially resembles *V. blanda* or *V. sororia* and is often found on herbarium sheets with them, but may be distinguished by its ovate, crenate leaves; stolons; purple-flecked capsules with auricles over 1

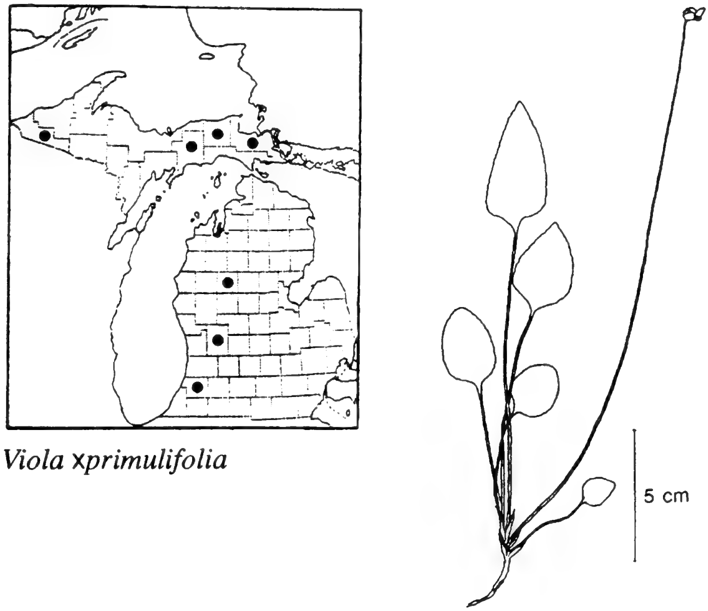


FIGURE 23. *Viola ×primulifolia*: Michigan distribution and spring habit.

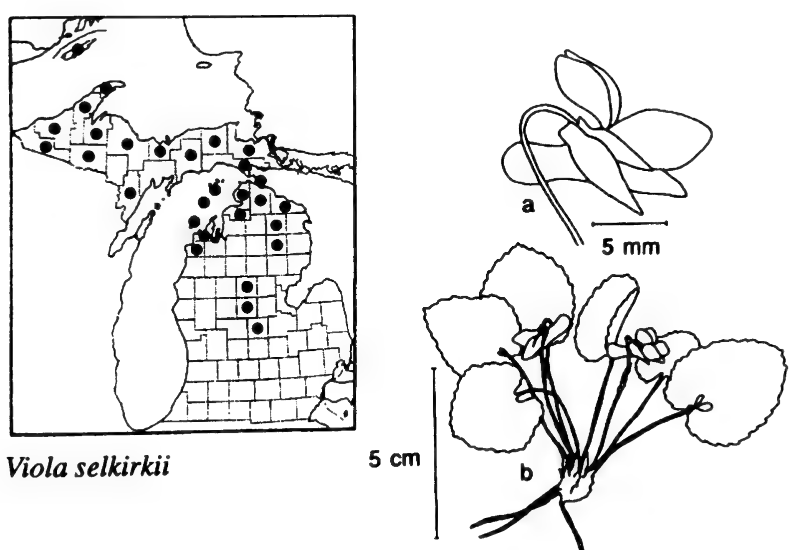


FIGURE 24. *Viola selkirkii*: Michigan distribution, (a) profile of flower, and (b) spring habit.

mm long; and small adnate stipules. Living plants have the basal lobes of the leaves commonly overlapping and the sinus very closed. The uniformly scattered, stiff whitish hairs on upper leaf surfaces are also helpful characters for separating sterile specimens of this from Plagiostigma or Boreali-Americanae violets without resorting to examining the small stipules for their adnate nature. The capsules resemble those of *V. sororia*. In a detailed study of morphological features, Russell (1956a) has found very little geographic variation over the North American range of the species.

This species is the sole North American representative of a predominantly Eurasian group with approximately two dozen species, all characterized by distinctly adnate stipules.

Clausen (1929) has counted $2n=24$ chromosomes in this species.

PEDATAE GROUP

25. *V. pedata* L.; Figs. 2 and 25.

KEY TO FORMS

1. Upper two petals deep purple, lower three blue............. f. *pedata*
1. All five petals blue.................................... f. *rosea*

25a. *V. pedata* L. f. *pedata*, Sp. Pl.:933. 1753.

COMMON NAMES: Bird's-foot violet, crowfoot violet

TOTAL RANGE: Vermont west to eastern Minnesota, south to Alabama and eastern Texas, the common form to the south and east of the species' range.

HABITATS: Oak or pine forests, savannas, and dry prairies in sand.

COMMENTS: More widespread in southern Michigan than either *V. pedatifida* or *V.* ×*palmata*, both of which also have dissected leaves and with which it has often been confused. It is easily distinguished by its frontally "flattened" flower, absence of beards on the lateral petals, barrel-like rhizome, and long, adnate stipules. The leaves of *V. pedata* differ subtly from those of *V. pedatifida*, with which it is commonly (although unnecessarily) confused, in having the central division usually unlobed, whereas the central division of *V. pedatifida* is dissected like the lateral divisions. Capsule and seed morphology are similar in the two.

The current species is unique in our native North American species in lacking cleistogamous capsules in nature—although it has reportedly produced them under cultivation (Hills 1946)—due to self-incompatibility (Becker 1988). The species has repeatedly been included in the stemless blue (Boreali-Americanae) group, but differs in numerous major characteristics of corolla, foliage, rhizomes, and in its self-incompatibility; it is tentatively placed in its own group, the Pedatae Pollard, pending the results of current phylogenetic studies on its taxonomic placement. A few members of the Violidium group occurring in southern Europe and west-central Asia have the deeply dissected leaves, long-adnate stipules, short, barrel-like rhizome, and xeric habitat of this species, and also share several floral features. The Eurasian representatives comprising the *V. pinnata* complex in the Violidium group may well be the nearest relatives of our enigmatic North American bird's-foot violet.

In the present form, f. *pedata*, the lower three petals are light blue and the upper pair are dark purple. This form ranks as one of the most striking and beautiful violets in eastern North America. It is, unfortunately, rare and local in Michigan. Thompson (1923) reported typical *V. pedata* (including "*var. bicolor*"), from 10 southern Lower Peninsula counties but listed "var. *inornata*" [= f. *rosea*] from only Van Buren County, apparently switching the county distributions for the two forms. Herbarium specimens for bicolored f. *pedata* include Kent, Muskegon, Newaygo, Ottawa, and Van Buren Counties.

Chromosome counts for the species were first presented as $2n = 56$ by Gershoy (1934), but later reported as $2n = 54$ by Canne (1987).

25b. *V. pedata* f. *rosea* Sanders, Rhodora 13:172. 1911.

V. pedata var. *lineariloba* DC., Prodr. 1:291. 1824.

COMMON NAMES: Bird's-foot violet, crowfoot violet

TOTAL RANGE: Vermont west to eastern Minnesota, south to Alabama and eastern Texas, more common in the northern and western portions of the species' range.

HABITATS: Oak or pine forests, savannas, and dry prairies in sand.

COMMENTS: In this form, all five petals are light blue.

While most floras and manuals have traditionally dealt with the concolorous plant as a distinct variety, var. *lineariloba* DC., a few have made it a synonym of *V. pedata* without giving it taxonomic distinction. Several authors have mentioned leaf lobing in connection with the name var. *lineariloba*, the original basis for segregating it but no longer tenable in light of the common co-occurrence of all leaf morphs on the same plant. No evidence for a correlation between floral color type and any other significant morphological, ecological, or strong geographic characteristics is apparent. Nevertheless, extensive literature reviews and studies of *Viola* from around the world have suggested that the bicolorous-concolorous corolla pattern, as exists in *V. pedata*, is unique in the world's violet flora. Consequently, two floral morphs are maintained as forms. For those recognizing the concolorous corolla type as distinct from the typical bicolored one at the rank of *forma* (but including insignificant populational color variants), the name f. *rosea* Sanders must be used as the earliest available epithet.

BOREALI-AMERICANAE GROUP

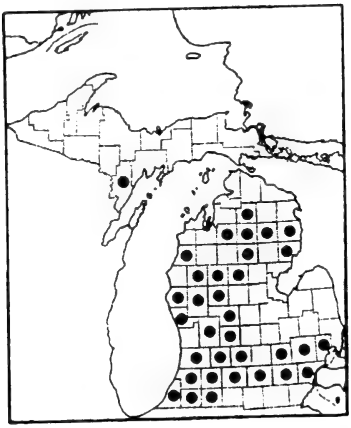
26. *V. affinis* Leconte, Ann. Lyceum Nat. Hist. New York 2:138. 1826; Fig. 26.

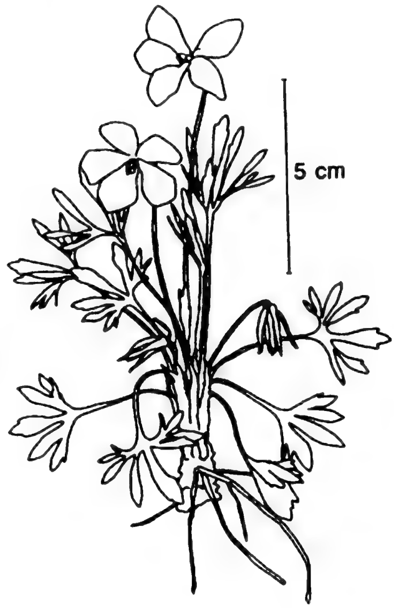
V. langloisii Greene, Pittonia 3:87. 1896.

V. missouriensis Greene, Pittonia 4:141. 1900.

V. rosacea Brainerd, Bull. Torrey Bot. Club 37:525. 1910.

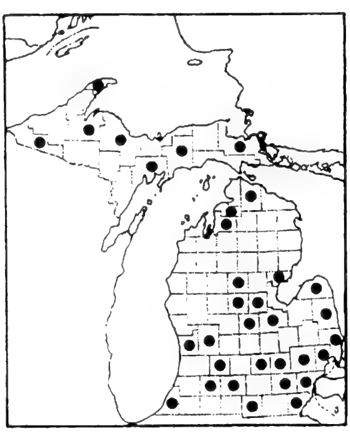
COMMON NAMES: Leconte's violet, thinleaf blue violet

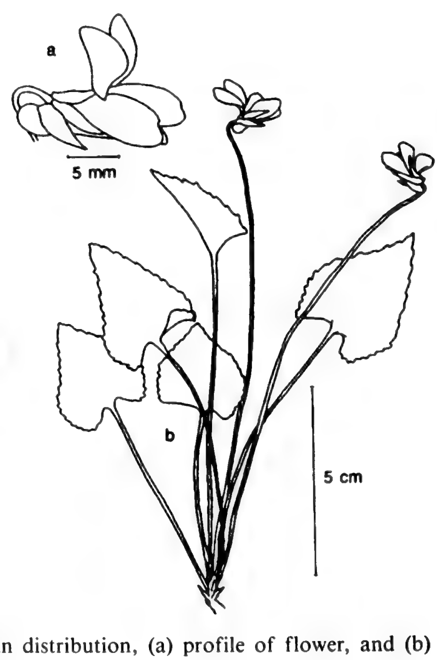




Viola pedata

FIGURE 25. *Viola pedata*: Michigan distribution and spring habit.





Viola affinis

FIGURE 26. *Viola affinis*: Michigan distribution, (a) profile of flower, and (b) spring habit.

TOTAL RANGE: Quebec and Massachusetts west to Ontario, south to Florida and Texas.
HABITATS: Typically saturated (occasionally drier) loam or muck soils of swamps, floodplains, and meadows, and along lakeshores and streams.
COMMENTS: This species differs from the common *V. sororia* in its typically glabrous, narrowly ovate leaves with acuminate apex and sharply acute sepals. It is similar to *V. sagittata* (and *V. novae-angliae*) in overall leaf outline but differs in its glabrous foliage, unlobed blades, short sepal auricles, and purple-flecked capsules on prostrate or arching peduncles.

Occasional flowering specimens approach *V. nephrophylla* and *V. sororia* in a less noticeably acuminate leaf shape and obtusish sepals. These have been placed with *V. affinis* on the basis of their swamp habitat and slender sepal outline. They may be the result of hybridization between the two subspecies of *V. sororia*. Russell (1965) noted as additional diagnostic characters stiff white hairs on the upper lamina of the leaves and cleistogamous capsules on arching peduncles. Mohlenbrock (1978) has found considerable variation in Illinois specimens with regard to such pubescence features; the same is true of Michigan material. Capsules are reportedly pubescent on occasion—a condition unknown in other species of the Boreali-Americanae group—but I have not observed this in living or herbarium specimens. Capsules and seeds are very similar to those of *V. sororia* (as are the seeds) although sometimes on arched-ascending rather than strictly prostrate peduncles.

The taxon called *V. missouriensis* has been distinguished in the past by its strictly glabrous foliage, glabrous spurred petal, and obtuse, ciliate sepals. Deam (1940) maps it immediately south of the state line in Indiana, and Mohlenbrock (1978) shows it in western Illinois. However, type specimens and collections from across its range are not very distinct from *V. affinis* on the one hand and *V. sororia* on the other. It varies (and hybridizes) extensively in the upper Midwest, making assignment of specimens virtually impossible and giving the impression that it represents at least in part ecotonal hybrid swarms involving *V. affinis* and *V. sororia*. Consequently, *V. missouriensis* is included as a synonym of *V. affinis* along with several other previously recognized but scarcely discernible taxa.

McKinney (1992) subordinates the present species and *V. missouriensis* to varieties under *V. sororia*. The present taxon is consistently distinct from *V. sororia* in several floral and foliage characters over most of its range (including Michigan), and is quite strongly isolated from *V. sororia* in its typical swamp/bottomland forest habitat. The taxon is therefore maintained at the species level.

It is usually found in deciduous swamps and meadows (sometimes near *V. nephrophylla*), whereas *V. cucullata* often inhabits coniferous or mixed lowland forest areas and bogs.

27. *V. cucullata* Aiton, Hort. Kew. 3:288. 1789; Fig. 27.

V. cucullata f. *albiflora* Britton, Bull. Torrey Bot. Club 17:124. 1890.
V. cucullata var. *microtitis* Brainerd, Rhodora 15:112. 1913.

V. cucullata f. *prionosepala* (Greene) Brainerd, Rhodora 15:112. 1913.
V. cucullata f. *thurstonii* (Twining) House, Bull. New York St. Mus. Nat. Hist. 254:504. 1924.

COMMON NAMES: Marsh blue violet, long-stemmed marsh violet
TOTAL RANGE: Nova Scotia and Maine west to Ontario and Minnesota, south to Georgia and Tennessee.
HABITATS: Swamps, sedge meadows, less often in fens and bogs.
COMMENTS: Distinctive among our stemless violets in its glabrous ovate leaves, glabrous spurred petal, sharply acute sepals with well-developed auricles, and long-ovoid green cleistogamous capsule with olive-black mature seeds. Flowering plants often have one or more of the largest leaves distinctly longer than broad but are distinguished from the superficially similar *V. affinis* by their glabrous spurred petal, strongly clavate beards on the lateral petals, and well-developed auricles. Specimens in flower are often confused with *V. nephrophylla* but may be distinguished by the above characters, as well as sharply acute sepals. In fruit the leaves broaden, at which time the species' distinctive long-ovoid capsule, elongate auricles (sometimes over 1 cm long), and blackish seeds set it apart from other taxa.

Other useful and more or less constant field characters include tall flowering peduncles that typically distinctly surpass the leaves, light purple corolla with a darker purple ring around the throat, and a comparatively short spurred petal blade relative to the lateral ones.

Specimens from the western Upper Peninsula and elsewhere at the northern end of the range bear shorter sepal auricles than plants to the south. The character appears to be clinal and such plants, called var. *microtitis* Brainerd, hardly seem deserving of taxonomic distinction. Other plants, most often northern ones, are sometimes pubescent on the leaves and have ciliate sepals. These have been separated as f. *prionosepala* (Greene) Brainerd; I have found the so-called form in close proximity to *V. sororia* and have concluded that it is probably the result of hybridization between *V. cucullata* and *V. sororia*.

Canne (1987) has reported $2n = 54$ chromosomes for the species.

28. *V. nephrophylla* Greene, Pittonia 3:144. 1896; Fig. 28.

V. pratincola Greene, Pittonia 4:64. 1899.
V. nephrophylla f. *albinea* Farw., Amer. Midl. Naturalist 11:64. 1928.

COMMON NAME: Northern bog violet
TOTAL RANGE: (Including the reported range for *V. pratincola*) from Nova Scotia and Maine west to British Columbia and Washington, south to Pennsylvania, Illinois, Arkansas, New Mexico, and California.
HABITATS: Fens, bogs, sedge meadows, and rocky shores in muck, marl, or rock crevices.
COMMENTS: Superficially similar to *V. cucullata* from which it differs in having a bearded spurred petal, threadlike petal beard hairs, very short auricles, and obtuse sepals. It is most often confused with *V. sororia* but differs clearly in fruit in its green cleistogamous capsules on erect peduncles, and mature olive-black seeds. Useful tendencies in separating flower-

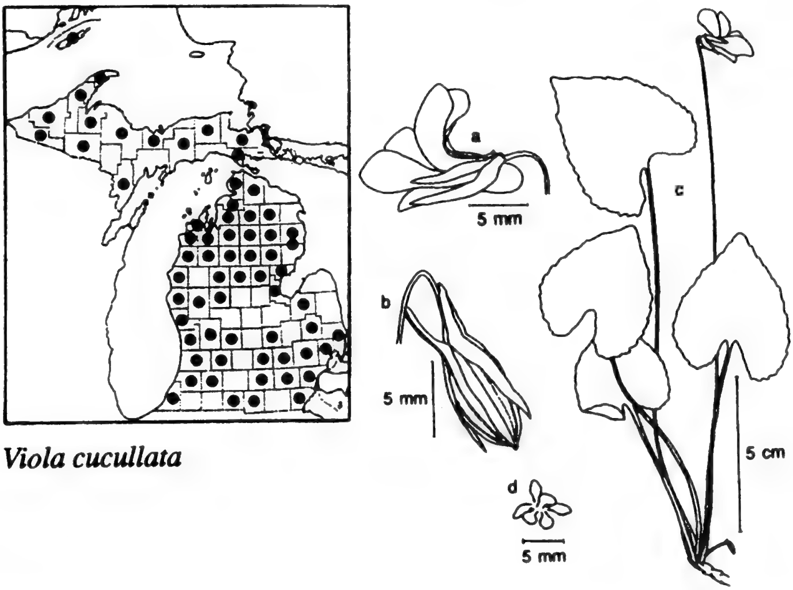


FIGURE 27. *Viola cucullata*: Michigan distribution, (a) profile of flower, (b) cleistogamous capsule, (c) spring habit, and (d) hairs of lateral petal beard.

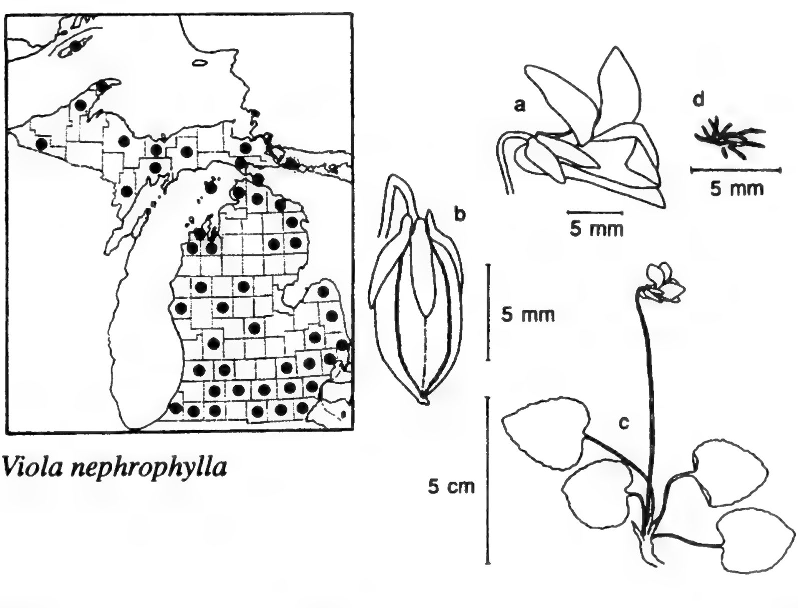


FIGURE 28. *Viola nephrophylla*: Michigan distribution, (a) profile of flower, (b) cleistogamous capsule, (c) spring habit, and (d) hairs of lateral petal beard.

ing specimens of *V. nephrophylla* from *V. sororia* are the typically glabrous foliage, longer peduncles than petioles (the flowers thus overtopping the leaves), and the long petioles relative to the leaf blades, being several to many times as long as the blades in mid-spring. Flowering plants are superficially similar in appearance to *V. sororia*, and pressed specimens may pose special difficulty if particulars of the habitat were not noted upon collection. The leaves commonly have a strong bluish tinge to the lower lamina, and occasionally all five petals are bearded-characters which supposedly distinguish the Cordilleran *V. cognata* Greene or *V. nephrophylla* var. *cognata* (see Scoggan 1979), although otherwise typical plants of Midwestern *V. nephrophylla* with all five petals bearded are not rare.

The spurred petal is always bearded within on inland Great Lakes region specimens, but is occasionally glabrous or sparsely bearded on specimens along northern Lake Huron and Lake Michigan shores. While a bearded spurred petal and essentially glabrous foliage are highly reliable features for identifying northeastern populations, these are much more variable and much less reliable in Great Plains and Cordilleran populations. Occasional specimens of degraded or successional sites in Michigan are sometimes found with slightly pubescent foliage. These invariably grow near *V. sororia*, and field conditions suggest that hybridization accounts for the atypical pubescence. Mohlenbrock's (1978) circumscription of Illinois *V. nephrophylla* as having lower leaf surfaces hirsutulous and capsules weakly globose does not match our plants and may refer to another taxon (e.g. *V. sororia*).

This and another taxon known as *V. pratincola* Greene have been treated in a variety of ways. Most taxonomists have treated *V. pratincola* as a synonym of the glabrate woodland violet long called *V. papilionacea* Pursh. Mohlenbrock (1978) and Russell (1965) have treated *V. pratincola* as a distinct prairie-dwelling species, distinguished morphologically by a glabrous spurred petal and abruptly acute leaves. Jones and Fuller (1955) have placed *V. nephrophylla* into synonymy under *V. papilionacea* without comment. McKinney (1992) recently lumped *V. affinis* with *V. nephrophylla* var. *arizonica* and var. *cognata* under *V. sororia* var. *affinis* (Leconte) McKinney, and placed *V. nephrophylla* var. *nephrophylla* in synonymy under *V. sororia* var. *sororia*. Recent studies of variation patterns in the unlobed ovate-leaved Boreali-Americanae across the Midwest, and examination of Greene's holotypes of *V. nephrophylla* Greene and *V. pratincola* Greene, have led me to conclude that these names—regardless of their previous applications by various taxonomists—refer to the same violet. The name *V. nephrophylla* Greene must be used as the earliest available name at the rank of species.

This species is exceedingly faithful to its characteristic alkaline, open wetland habitat and may be distinguished in the field from *V. sororia* on virtually that feature alone. A helpful, albeit variable and qualitative difference between *V. nephrophylla* and *V. cucullata* lies in the corolla color pattern and the relative length of the spurred versus lateral petals. The corolla of *V. nephrophylla* is dark purple without a noticeably darker contrasting ring around the throat, and the spurred petal is only slightly shorter than the laterals, while the corolla of *V. cucullata* tends to be light purple with a noticeably darker purple ring around the throat, and the spurred petal is quite short relative to the laterals. In addition, *V. nephrophylla* only very rarely inhabits forested situations, whereas *V. cucullata* is often found in moist forests, swamps and bogs.

Brainerd (1921) deemed this species as having the most extensive range of all violets indigenous to North America. Aside from this, *V. nephrophylla* and *V. cucullata* are perhaps two of the least morphologically variable of the Boreali-Americanae group in North America.

Occasional plants produce white flowers, for which the name f. *albinea* Farw. was published for specimens from Erie, Monroe County. Additional specimens have been seen from Grand Traverse County. Greene's holotype of *V. crassula*, described for a specimen from the vicinity of Jackson in Jackson County, and the holotype of *V. peramoena* Greene, collected near Marengo in the same county, are slightly pubescent forms of *V. nephrophylla*, probably resulting from hybridization with *V. sororia*.

Canne (1987) reported the species as having $2n = 54$ chromosomes.

29. *V. novae-angliae* House, Rhodora 6:226. 1904; Fig. 29.

V. septentrionalis Greene var. *grisea* Fernald, Rhodora 37:301.1935.

COMMON NAME: New England violet

TOTAL RANGE: New Brunswick and Maine; disjunct in western Ontario to southeastern Manitoba, south to Michigan's Upper Peninsula, northern Wisconsin, and Minnesota.

HABITATS: Open mixed hardwood or conifer forests, also along lakes and streams, on sand or rock.

COMMENTS: Similar in overall leaf outline (and xeric habitat) to *V. sagittata*, this species is primarily distinguished by its unlobed leaves, rounded sepals with poorly developed auricles, and purple-flecked cleistogamous capsules on prostrate to arching peduncles. It is also similar in many respects to *V. sororia*, but has consistently narrowly ovate-triangular leaves much longer than wide and occupies a distinctly drier habitat.

This species has the most restricted range of all our Great Lakes stemless blue violets. The taxon has two centers of distribution, one in the northwestern Great Lakes and the other in the New England/maritime provinces (Ballard & Gawler 1995). It has its best representation in our region. It is well distributed in northern Minnesota, western Ontario, northern Wisconsin, and Maine, but rare in Michigan, New Brunswick, and New York.

Farwell (1930) erroneously reported this taxon from Eloise in Wayne County—perhaps mistaking for this one of the *V. sagittata sensu lato* specimens which he distinguished and discussed at some length in the same paper.

Fernald (1935) described *V. septentrionalis* var. *grisea* from specimens collected near Driggs in Schoolcraft County (*Fernald & Pease #3430*, 7/2/1939, GH, MICH). He distinguished it from *V. septentrionalis* var. *septentrionalis* by its whitish pubescence and long-triangular leaves, and from *V.*

novae-angliae by its ciliate sepals. A recent taxonomic study of field populations and herbarium specimens across the range of the taxon (Ballard 1989) failed to uphold the *grisea* entity, in light of considerable (and previously unappreciated) within-population and geographic variation in foliage pubescence and sepal ciliation.

McKinney (1992) has subordinated the New England violet to a variety under *V. sororia* (using the epithet *novae-angliae* rather than *grisea*, as should have been done), but the taxon is here maintained as a separate species because of consistently different leaf morphology and certain capsule tendencies, restriction to xeric rock and sand habitats, and only very rare hybridization with *V. sororia*. Morphological similarities shared with both *V. sagittata* and *V. sororia*, distribution, and ecological similarity with *V. sagittata* suggest that further intensive studies should be conducted to evaluate the potential of a hybrid origin for *V. novae-angliae* from the other two species.

30. *V. pedatifida* G. Don, Gen. Sys. Gard. Dict. 1:320. 1831; Fig. 30.
COMMON NAMES: Prairie violet, larkspur violet
TOTAL RANGE: Southwestern Ontario and Ohio west to Alberta, south to Illinois and Oklahoma; disjunct in Arizona, New Mexico, and Virginia (Platt 1950).
HABITATS: Mesic loam prairies, ecotones of oak savanna-sand prairie (Newaygo and Oakland Counties) and prairie-like areas (e.g. a pasture atop a limestone bluff at the Delta County location).
COMMENTS: This species is striking, as is *V. pedata*, in having deeply dissected leaves, but is immediately distinguished from the latter by its bearded lateral and spurred petals, short nonadnate stipules, and prostrate-ascending rhizome.

The prairie violet is essentially identical to *V. sagittata sensu lato* in floral and fruit morphology, but differs in deeply dissected leaves, mesic blacksoil prairie habitat, and midwestern distribution. The species is very conservative in habitat preference and very locally distributed, occurring (at least in our area) only in blacksoil prairie/savanna remnants that are largely confined to the Prairie Peninsula made famous by Transeau (1935). Reports of the species by naturalists unfamiliar with its distinguishing features have invariably turned out to be *V. pedata*, which is widespread in somewhat similar (but noticeably drier) sites across the Lower Peninsula.

Brainerd (1921), Fernald (1950), and Russell (1965) have recommended merging this species and *V. palmata* var. *angellae* on the basis of apparent intergradation between the two in the Great Lakes region. Gleason and Cronquist (1991) have recently made this change. I have suggested a different interpretation for the presence of apparent intermediates in the Great Lakes region (see the previous taxon discussion), noting that the "intergradation" resulted from confusion of backcrosses or segregates of a hybrid swarm thriving adjacent to populations of typical *V. pedatifida*.

Russell's (1956b) assertion that this species is weedy is inaccurate. It persists, at least in our state, where other less hardy prairie species have

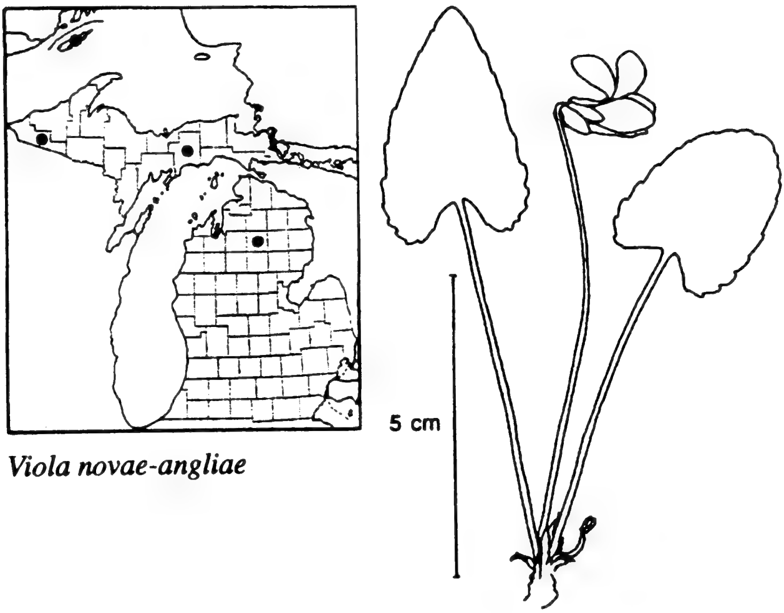


FIGURE 29. *Viola novae-angliae*: Michigan distribution and spring habit.

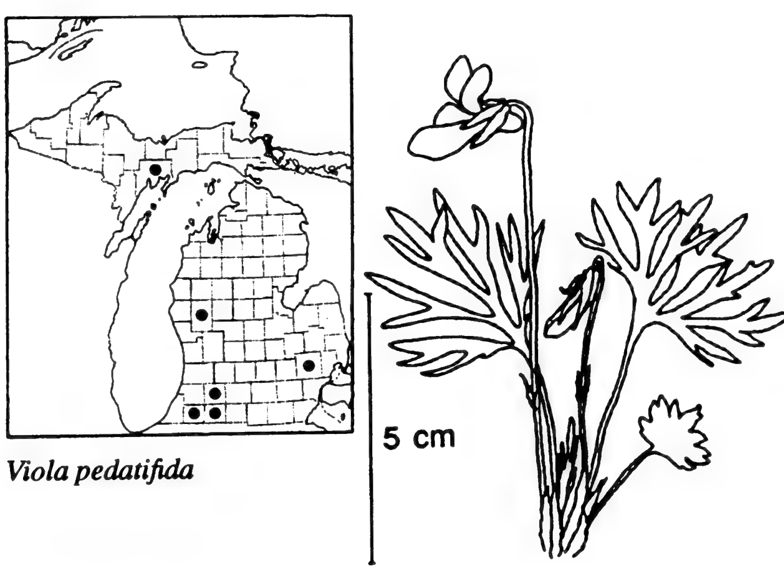


FIGURE 30. *Viola pedatifida*: Michigan distribution and spring habit.

been eliminated through degradation of Michigan's prairies, but fails to expand its local range to nonprairie remnants nearby. Indeed, despite extensive searches by myself and others, populations have never been found outside the documented boundaries of the state's historic prairies and prairie-like savannas (Ballard 1980). The rarity of the species and the imperiled nature of its all but vanished habitat have resulted in the dubious honor of "state-threatened" status in Michigan.

Farwell (1917b) reported this species on the basis of a specimen from Lapeer County which, in an addendum, he acknowledged was *V. pedata*.

31. *V. sagittata* Aiton

KEYS TO VARIETIES

1. Foliage glabrous to moderately short-pubescent; leaves held erect in life; blades oblong-lanceolate to long-triangular, commonly shallowly to deeply lobed at base with linear segments, especially at fruiting time; petioles longer than blades, in fruit to 2–4 times as long as blades .... var. *sagittata*
1. Foliage densely short-pubescent; leaves held prostrate or weakly ascending in life; blades elliptic to ovate, at most coarsely serrate at base; petioles shorter than or equalling blades ....var. *ovata*

31a. *V. sagittata* Aiton var. *sagittata*, Hort. Kew. 3:287. 1789; Fig. 31.

V. emarginata (Nutt.) Leconte, Ann. Lyceum Nat. Hist. New York 2:142. 1826.

V. sagittata var. *subsagittata* (Greene) Pollard, Bot. Gaz. 26:340. 1898.

COMMON NAMES: Arrow-leaved violet, triangle-leaf violet

TOTAL RANGE: Massachusetts west to eastern Minnesota, south to Georgia and Texas.

HABITATS: Mesic sand prairies and sedge meadows, swales in oak and pine forests, open dry-mesic sites in oak forests, and old fields; occasionally in heavy clay soil.

COMMENTS: This species represents our only stemless violet having narrowly triangular-ovate leaf blades that are (commonly) lobed with short linear segments at the base. Individuals in many populations of the *V. sagittata* complex that occupy large, visually uniform habitats often exhibit great diversity in pubescence, leaf blade outline, and lobing. Pubescent extremes in the Midwest have sometimes been segregated unnecessarily as var. *subsagittata* (Greene) Pollard, but presence/absence of pubescence alone shows little clear correlation with other morphological features, geography, or microhabitat.

Habit is an important field character and consistent distinction in living plants of the two taxa; curiously, this difference has not been noted in the literature. In var. *sagittata* the leaves are erect on tall petioles, whereas in var. *ovata* they are ascending or nearly prostrate on short petioles, thus resembling an "African violet" rosette. This habit distinction, as with other diagnostic characters for the two taxa, is most unambiguous on fruiting plants. The prostrate habit of leaves in var. *ovata* is shared by only two other stemless blue violets, the predominantly southeastern *V. villosa* Walter (which shares many other morphological features and a dry savanna habitat) and the predominantly Appalachian *V. hirsutula* Brainerd.

Brainerd (1921), Fernald (1950), Russell (1965) and others have treated this and the following taxon as separate species. A considerable degree of morphological variability within populations of the two extremes, significant intergradation (or overlap) in character states between them across the Midwest, and incomplete ecological differentiation has prompted me to recognize a single polymorphic species with a widespread and broadly defined variety (var. *sagittata*) and a more narrowly delimited, more geographically restricted variety (var. *ovata*). McKinney (1992) has maintained the two varieties, whereas Gleason and Cronquist (1991) have submerged var. *ovata* under *V. sagittata*. Cronquist (pers. comm.) justified merging the two taxa on the basis of supposed reciprocal transplant studies using meadow and forest populations of var. *ovata* (as *V. fimbriatula*), that demonstrated considerable modification of petiole length—an important distinction between the two taxa—with change of environmental conditions. Examination of the photograph of the "*V. fimbriatuala*" and "*V. sagittata*" individuals in the transplant study, however, reveals that sun and shade forms of *V. sagittata* var. *sagittata* and not both taxa were used, making the transplant study, and Cronquist's subsequent merger of the two taxa, invalid. Recent field studies have confirmed additional features distinguishing this taxon (as a narrowly defined entity), including the reclining leaf habit and absence of well-developed basal lobes.

Thompson (1923) reported *V. subsagittata* from Eaton County as "a pubescent form, recognized by Brainerd." Farwell (1928) published the name *V. nephrophylloides* Farw. for a plant from Monroe County which turned out to be a hybrid of *V. nephrophylla* and *V. sagittata*.

Canne (1987) has reported the species as having $2n = 54$ chromosomes.

31b. *V. sagittata* var. *ovata* (Nutt.) Torr. & A. Gray, Fl. N. Amer. 1:138. 1838; Fig. 32.

V. fimbriatula Sm., Rees' Cycl. 37, No. 16. 1817.

COMMON NAME: Ovate-leaved violet

TOTAL RANGE: Maine west to central Michigan, south to northeastern Alabama and eastern Ohio.

HABITATS: Open oak forests and dry prairies in sand.

COMMENTS: Similar to var. *sagittata* above, this variety is narrowly delimited by its unlobed (merely coarsely serrate) leaves, prostrate leaf habit, consistently densely pubescent foliage, and petioles about as long as blades (or less). This taxon might be confused with *V. sororia* or *V. novae-angliae* but is easily separated by its narrowly ovate leaves, sharply acute sepals, well developed auricles, green capsules on erect peduncles, and shorter foliage pubescence.

This taxon is not as reliably distinguished from the previous one, at least in Michigan, as Russell (1965) and others have asserted. The two are variable extremes that possess a number of differing morphological tendencies,

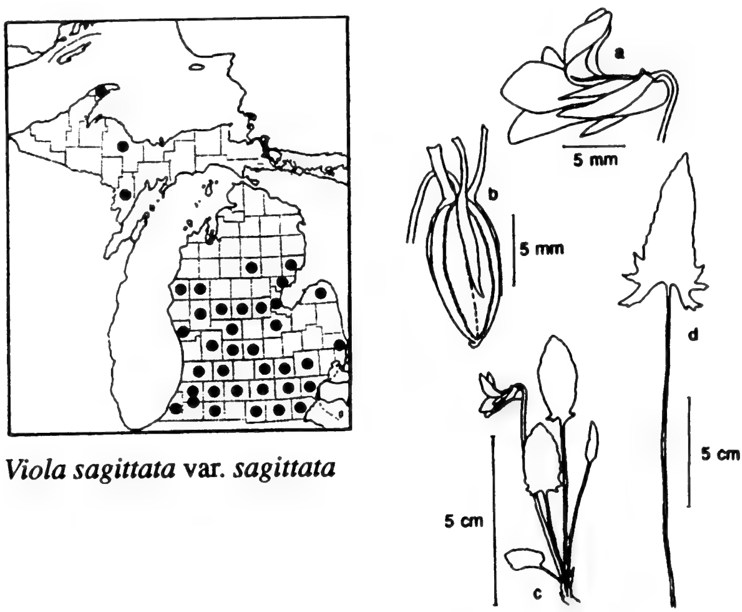


FIGURE 31. *Viola sagittata* var. *sagittata*: Michigan distribution, (a) profile of flower, (b) cleistogamous capsule, (c) spring habit, and (d) summer leaf.

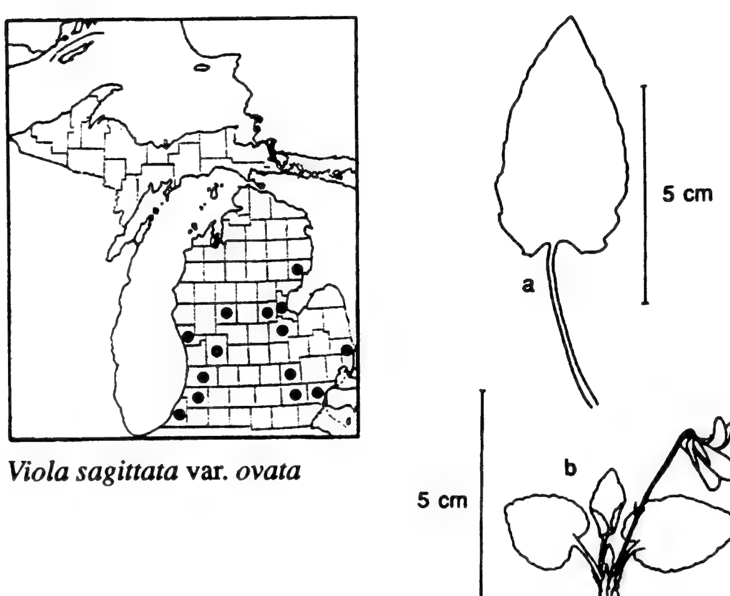


FIGURE 32. *Viola sagittata* var. *ovata*: Michigan distribution, (a) summer leaf, and (b) spring habit.

distinctly divergent leaf habit, and incomplete ecological differentiation. Deam (1940) pointed out that the characters distinguishing them overlap strongly, to the extent that many specimens cannot be placed in either taxon; this is certainly true in Michigan, where I have found approximately a third of specimens encountered assignable to either variety. For fear of losing some potentially important evolutionary information, I have chosen not to lump the two together but to distinguish var. *ovata* in a very narrow sense. Plants have been assigned to var. *ovata* if they possessed all characters as defined in the keys. Specimens meeting these criteria are typically from dry upland sites, usually in prairie-like openings in dry oak forests, especially near the lakeplain of Lakes Michigan and Huron. The bulk of specimens referrable to *V. sagittata sensu lato* possess some characters of both extremes, and these have been placed in var. *sagittata* as a broadly delimited taxon. It is likely that the morphological intergradation (or overlap) of diagnostic features in many problematic populations is the result of past or current local hybridization. Further studies of this complex are needed to understand the delimitation and relationships of the complex, including both varieties and the morphologically closely related *V. villosa*.

32. *V. sororia* Willd., Enum. Pl.:263. 1809; Figs. 3 and 33.

V. septentrionalis Greene, Pittonia 3:334. 1898.

V. domestica Pollard, Britton & Brown Illus. Fl. 3:519. 1898.

V. latiuscula Greene, Pittonia 5:93. 1902.

V. priceana Pollard, Proc. Biol. Soc. Wash. 16:127. 1903.

V. septentrionalis f. *alba* Vict. & M. Rousseau, Contr. FInst. Bot. Univ. Montr)al 36:20. 1904.

V. sororia f. *beckwithae* House, Bull. New York State Mus. Nat. Hist. 243–244:40. 1923.

V. papilionacea f. *albiflora* Grover, Ohio J. Sci. 39:148. 1939.

V. sororia f. *priceana* (Pollard) Cooperr., Michigan Bot. 23:167. 1984.

COMMON NAMES: Woolly blue violet, hairy wood violet

TOTAL RANGE: Nova Scotia west to British Columbia, south to Florida and Texas.

HABITATS: Mesic sugar maple forests, dry-mesic hardwood and mixed forests, less often in swamp or floodplain forests.

COMMENTS: This species is usually easy to identify by its typically long-pubescent, ovate, unlobed leaves, blue corollas with spurred petal glabrous (or with a few hairs), obtuse sepals with weakly-developed auricles, and purple-flecked capsules on prostrate peduncles. Infrequent specimens with some of the leaves becoming acute or subacuminate at the apex can be told from *V. affinis* by their (commonly) pubescent foliage, more obtuse (though sometimes narrow) sepals, and glabrous or sparingly bearded spurred petal. Infrequent glabrate specimens that are otherwise typical, often forming uniform subpopulations, are distinguished from *V. cucullata*, *V. nephrophylla*, and *V. affinis* by their mesic or dry-mesic habitat preference, and, in fruit, by their heavily purple-flecked cleistogamous capsules on predominantly prostrate peduncles. Such plants have been distinguished as

V. domestica Bicknell as well as *V. papilionacea* auct. *non* Pursh, but are otherwise indistinguishable from typical villous *V. sororia*.

This taxon is the characteristic purple violet of Michigan's mesic forests and fencerows. While the typical morph with longpubescent foliage and broad obtuse leaves is immediately recognizable, occasional specimens with most leaves acute or acuminate and sepals slender may be found in low-lying areas of forest near typical *V. affinis*. These are probably the result of local hybridization in the zone of contact between the two subspecies.

The species as treated here includes *V. septentrionalis* Greene, which was originally distinguished on the basis of different sepal ciliation pattern and more northern distribution. Sepal ciliation varies considerably in the complex, with some populations bearing both eciliate and ciliate sepals. While northern populations inhabiting dry-mesic forests can be distinguished with great difficulty (sometimes) using the subtle features of slightly broader, more rounded sepals and slightly more elongate auricles, segregating such a weakly differentiated geographic variant at the species level seems contrary to the development of a practical classification for *Viola*.

The names *V. papilionacea* Pursh and *V. pratincola* Greene have been applied by lay taxonomists and specialists to a variety of stemless blue violets including *V. affinis* Leconte, *V. nephrophylla* Greene and, especially, glabrate or glabrous populations of *V. sororia* Willd. Typification studies of this glabrous violet morass have revealed that the name *V. pratincola*, believed by Brainerd to be a synonym of *V. papilionacea* Pursh and by Mohlenbrock (1978) and Russell (1965) to represent a distinct Midwestern prairie violet, is based on specimens that are identical to the holotype of *V. nephrophylla*, making *V. pratincola* a synonym. On the other hand, the name *V. papilionacea* Pursh may in fact not apply to *V. sororia* at all, as it has most often been used, but to the taxon treated here as *V. affinis*.

The occasional white-flowered form recognized by some as *V. sororia* f. *beckwithae* or *V. septentrionalis* f. *albiflora*, known from Kalamazoo and Manistee Counties, is not considered taxonomically significant. The often criticized "Confederate violet", treated previously as *V. priceana* Pollard or as a variety or form under *V. sororia* Willd. (see Cooperrider 1984), appears in gardens as a cultivar but also as an evidently naturally occurring form of low ground in mesic forests and floodplains. Presumably native populations are represented by specimens from Ingham and Kalamazoo Counties; I have also seen but not collected it in Lenawee County.

Canne (1987) has reported $2n = 54$ chromosomes for the species.

33. *V.* ×*palmata* L. (pro sp.), Sp. Pl.:933. 1753; Fig. 34.

V. esculenta Elliott, Bot. South Carolina & Georgia 1:300. 1816.
V. triloba Schwein., Amer. J. Sci. 5:57. 1822.
V. viarum Pollard, Britton's Man.:635. 1901.
V. stoneana House, Bull. Torrey Bot. Club 32:253. 1905.
V. chalcosperma Brainerd, Bull. Torrey Bot. Club 37:523. 1910.
V. langloisii var. *pedatiloba* Brainerd, Bull. Torrey Bot. Club 38:2. 1911.

COMMON NAME: Three-lobed violet

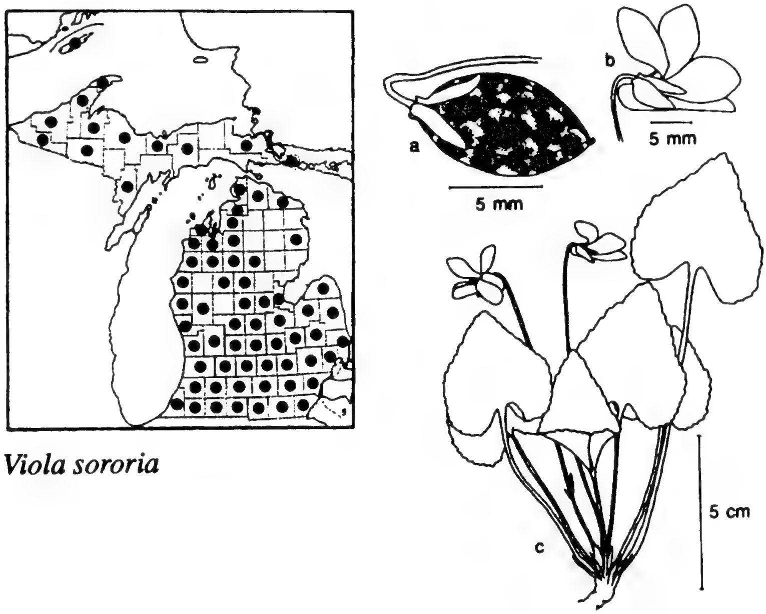


FIGURE 33. *Viola sororia*: Michigan distribution, (a) cleistogamous capsule, (b) profile of flower, and (c) spring habit.

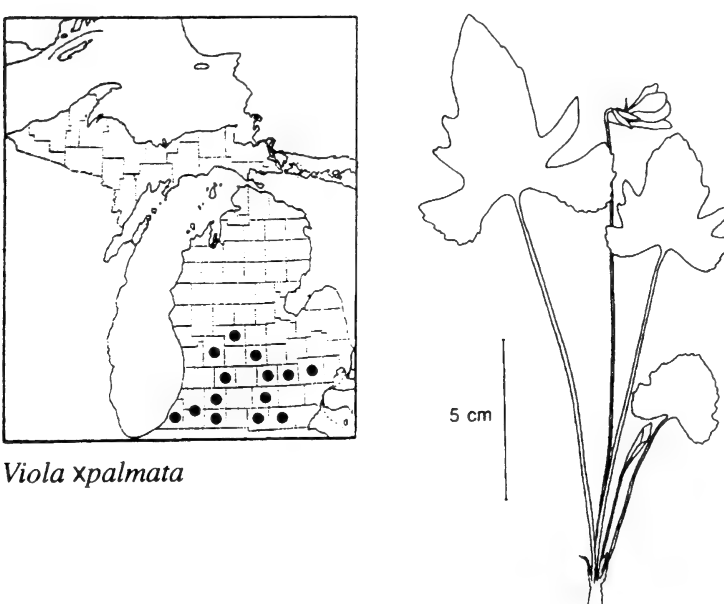


FIGURE 34. *Viola ×palmata*: Michigan distribution and spring habit.

TOTAL RANGE: New Hampshire west to central Michigan and southeastern South Dakota, south to Florida and Texas.
HABITATS: Oak forests and above the edge of marsh borders in sandy loam.
COMMENTS: This and the next hybrid are similar to *V. sagittata* var. *sagittata* in having shallowly lobed leaves but differ from it in leaf blades being broadly ovate, with lobes not confined to the basal fourth of the blade, and in bearing purple-flecked cleistogamous capsules on prostrate to arching peduncles. In certain sites, this taxon converges on *V. pedatifida* but may be distinguished by the distinctly longer foliage pubescence and purple-flecked capsules on short, prostrate peduncles.

Brainerd (1910) appears to be the original source for the misapplication of the name *V. palmata* L. as a species to the homophyllous, palmatifid taxon treated below as *V.* ×*subsinuata* Greene. Greene (1896) and McKinney (1992) have argued convincingly that Linnaeus' description and the specimens cited by him refer primarily (if not exclusively) to the heterophyllous, pedately cut taxon called by the superfluous name *V. triloba* by Brainerd and all later specialists. Although I differed in my interpretation prior to further investigation (see Voss 1985), I have recently accepted this argument in light of the evidence.

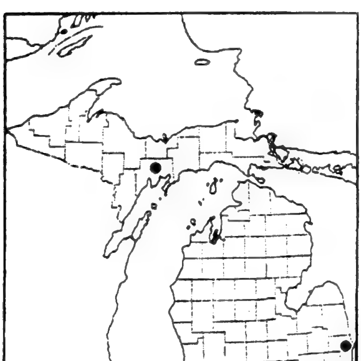
The delimitation of taxa and application of names in the *V. palmata* complex has been very confused, especially since the turn of the century. Fernald (1950) has suggested that it should perhaps include *V. triloba* Schwein. (= *V.* ×*palmata* L. of this treatment) and *V. sororia*. McKinney (1992) has implied that morphological features diverge greatly in the two taxa, and this has provided the basis for why he retained them as separate species, the current taxon as *V. palmata* and the next as *V. subsinuata* Greene. The only consistent distinction I have been able to determine in field and herbarium specimens across the range of the complex consists of a pair of linked traits expressing leaf lobing ("pedate" versus "palmate") and presence/absence of lobing in early and late-season leaves. While the two taxa have not been found at the same sites in Michigan, they co-occur and even intermingle elsewhere in the eastern United States. Furthermore, their dry-mesic to mesic, often disturbed habitats are edaphically and floristically very similar. I maintain them here as separate hybrid combinations for convenience, and so as not to obscure their different origins.

My own field studies in Michigan and adjacent states have provided morphological, ecological, and pollen viability evidence that the *V. palmata* complex in a broad sense comprises populations recently (and currently) derived through hybridization between *V. sororia* on the one hand and *V. sagittata sensu lato* (in *V.* ×*palmata*) and *V. pedatifida* (in *V.* ×*subsinuata*) on the other, as well much older populations (notably in the Appalachian region and further south) which themselves may well have a hybrid origin. The difficulty of reaching an appropriate (both phylogenetically informative and pragmatic) solution for the scope of this flora has forced me to treat Great Lakes populations recently or currently involving *V. sagittata* × *sororia* as *V.* ×*palmata*, and those involving *V. pedatifida* × *sororia* as *V.*

×*subsinuata*, with the "×" designation to indicate our populations as being spontaneously and recurrently derived. Further, extensive studies are required, perhaps including molecular methods, to clarify the evolutionary processes operating in this complex and—hopefully—a rational, pragmatic nomenclatural approach to naming entities included herein.

34. *V.* ×*subsinuata* Greene (pro sp.), Pittonia 4:4. 1899; Fig. 35.
V. palmata auct. non L.
V. pedatifida × *sororia*
COMMON NAMES: Early blue violet, hand-leaved violet
TOTAL RANGE: Massachusetts west to Minnesota, south to Georgia and Oklahoma.
HABITATS: Mesic prairie-forest ecotones and savannas.
COMMENTS: Morphology is essentially identical to *V.* ×*palmata*, except that all leaves are moderately to deeply lobed, the central division lobed like the lateral.

McKinney (1992) has recently emphasized the heterophylly-homophylly distinction, maintaining this as a distinct species, *V. subsinuata* Greene, and kindly supplied a photograph of the holotype at ND-G. In unpublished field and herbarium studies of *V. pedatifida* populations in the Great Lakes region (Ballard 1980), I found that most sites of well-defined *V. pedatifida* also harbored *de novo* hybrids with *V. sororia*, which grew nearby in mesic



Viola ×*subsinuata*

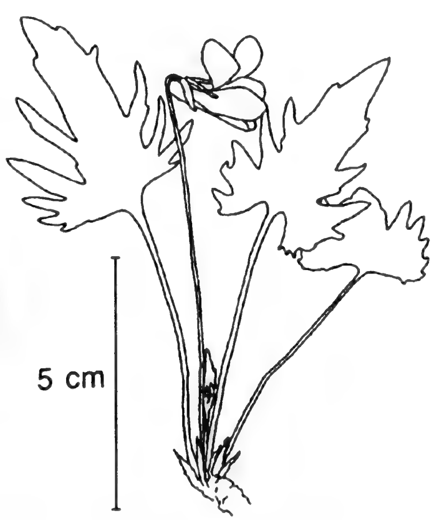


FIGURE 35. *Viola* ×*subsinuata*: Michigan distribution and spring habit.

forest sites. These hybrids occupied ecotonal and disturbed areas, and were identical with specimens of "*V. palmata*" from the states further east, where *V. pedatifida* was not known. Many individuals from southeastern Michigan populations of *V.* ×*subsinuata* approached *V. pedatifida* in morphological features and occupied more prairie-like microhabitats within the broader forest habitat. These observations led me to conclude that *V. pedatifida*, once native to southeastern Michigan, had been eliminated through succession, being replaced by hybrid derivatives with *V. pedatifida* genes that provided the plants adaptive advantages to persist in the closed canopy forests. Misled by examinations of (flowering) herbarium specimens alone, both Russell (1965) and Cronquist (1991) interpreted variation in the *V. pedatifida-palmata* melange simplistically to represent intergradation of *V. pedatifida* and "*V. palmata*" in the western Great lakes region. The latter author invoked this inaccurate and sweeping interpretation in his new combination, *V. palmata* L. var. *pedatifida* (G. Don) Cronq.

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CONTENTS

On the cover: The Canada violet, *Viola canadensis* (photo by R. Holzman).